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# FLOOD PLAIN INFORMATION

## FLATHEAD, STILLWATER AND WHITEFISH RIVERS

# KALISPELL - COLUMBIA FALLS

## MONTANA

PREPARED FOR
MONTANA STATE WATER RESOURCES BOARD
BY
CORPS OF ENGINEERS, U.S. ARMY
SEATTLE, WASHINGTON, DISTRICT

SEPTEMBER 1969

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COVER PHOTOGRAPH

Aerial view of June 1964 flood in the Evergreen district.
(Photo courtesy of Mel Ruder, Editor, Hungry Horse News.)

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# INTRODUCTION

This report relates to the flood situation along the Flathead, Stillwater and Whitefish Rivers near the cities of Kalispell and Columbia Falls, Montana. The Montana State Water Resources Board requested this report be prepared to aid in the solution of local flood problems and in the best utilization of land subject to overflow. The report is based on rainfall, runoff, historical and current flood heights, and other technical data bearing upon the occurrence and size of floods in the Kalispell-Columbia Falls area.

The report covers two significant phases of the Kalispell-Columbia Falls flood problem. First, it brings together a record of the largest known floods on the Flathead, Stillwater and Whitefish Rivers. Second, it treats of probable future floods: Namely, Intermediate Regional Floods and Standard Project Floods. Intermediate Regional Floods have an average frequency of occurrence of once in 100 years and are determined from an analysis of known floods on the Flathead, Stillwater and Whitefish Rivers and other streams which have similar physical characteristics in the same general geographical region. Standard Project Floods are of rare occurrence and, normally on most streams, are usually larger than floods that have occurred. However, the June 1964 flood experienced in the Kalispell-Columbia Falls area was approximately 70 percent greater in magnitude than the calculated Standard Project Flood on Flathead River. This is an extremely rare event. Most urbanized areas have not experienced the disastrous effects of floods larger than the Standard Project Flood. Communities with urbanized areas in the flood plain, but which have not experienced the catastropic effects produced by the June 1964 flood, are lulled into a false sense of security and do not practice wise and prudent planning in the flood-prone areas.

In planning for the control of development in the flood plains of Flathead, Stillwater and Whitefish Rivers and in making decisions on the size of floods to consider for this purpose, appropriate consideration should be given to the occurrence of floods of the magnitude of the Intermediate Regional Floods and the Standard Project Floods and to the recurrence of the June 1964 flood.

The report contains maps, profiles, and cross sections indicating the extent of past and probable future flooding in Kalispell, Columbia Falls and the immediate vicinity. The report should prove helpful in planning the best use of the flood plains. From the maps, profiles, and cross sections, the depth of probable flooding either by recurrence of the June 1964 flood or by occurrence of the Intermediate Regional or Standard Project Floods at any location may be learned. With this information, floor levels for buildings may be planned high enough to avoid flood damage or, if at lower elevations, with recognition of the chance and hazards of flooding that are being taken.

The report does not include plans for the solution of flood problems. Rather, the report is intended to provide the basis for further study and planning on the part of the Montana State Water Resources Board, the cities of Kalispell and Columbia Falls and Flathead County in arriving at solutions to minimize vulnerability to flood damages. This might involve local planning programs to guide developments by controlling the type of use made of the flood plain through zoning and subdivision regulations, the construction of flood protection works, or a combination of the two approaches.

The Seattle District of the Corps of Engineers will, upon request, provide technical assistance to Federal, State, and local agencies in the interpretation and use of the information contained herein and will provide other available flood data related thereto.

# SUMMARY OF FLOOD SITUATION

The city of Kalispell is 16 river miles downstream of Columbia Falls. These two cities are on the right bank of the Flathead River (see Plate 1). The Flathead River flows in a southerly direction past the cities of Kalispell and Columbia Falls. The Stillwater River joins the Flathead River from the west at the eastern city limits of Kalispell. The Whitefish River joins the Stillwater River about 3 miles upstream from the mouth. This report covers the Flathead River from 1 mile below Kalispell upstream to Columbia Falls and the lower 5 and 3 miles of the Stillwater and Whitefish Rivers, respectively.

Portions of Kalispell and Columbia Falls are in the flood plain. Commercial and residential developments in and adjacent to these cities were heavily damaged during the June 1964 flood.

The U. S. Geological Survey has maintained a stream gaging station on the right bank of the Flathead River downstream from the county road bridge at Columbia Falls since May 1922. Stream gaging stations installed on the lower Stillwater and Whitefish Rivers in 1929 were discontinued in September 1950. Residents along the streams have been interviewed and newspaper files and historical documents searched for information concerning past floods. From these investigations and from studies of possible future floods on Flathead, Stillwater and Whitefish Rivers, the local flood situation both past and future, has been developed. The following paragraphs summarize the significant findings which are discussed in more detail in succeeding sections of this report.

* * *

THE GREATEST FLOOD on the Flathead River during the last 75 years occurred in June 1964. The greatest known flood on Stillwater River and Whitefish River occurred in May 1948.

* * *

ANOTHER GREAT FLOOD, in June 1894, was the second highest flood on the Flathead River. This flood was 2.9 feet lower than the June 1964 flood at the gaging station, Flathead River at Columbia Falls. Floods occurred on the Stillwater River in May 1947 and on Whitefish River in June 1950 that are the second largest floods between 1929 and 1950, the period when the U. S. Geological Survey maintained stream gaging stations on these rivers.

* * *

OTHER LARGE FLOODS on the Flathead River occurred in May 1948 and May 1954. The May 1948 flood, the third largest known flood on the Flathead River, was 6.5 feet lower than the June 1964 flood at Columbia Falls. The May 1954 flood, regulated by Hungry Horse Dam, was 10 feet below the 1964 flood. On Stillwater River and Whitefish River minor floods have occurred repeatedly in the past.

* * *

INTERMEDIATE REGIONAL FLOODS on the Flathead, Stillwater and Whitefish Rivers are floods that have an average frequency of occurrence in the order of once in 100 years. They are determined from an analysis of floods on these streams and other streams in the same general area.

The analysis indicates the Intermediate Regional Flood for the Flathead River regulated by Hungry Horse Dam varies from 2.5 to 9.0 feet lower than the June 1964 flood.

* * *

STANDARD PROJECT FLOOD determinations indicate the Flathead River at Columbia Falls gage would be 6.9 feet lower than the June 1964 flood and 1.9 feet higher than the Intermediate Regional Flood. Northeast of Kalispell, near the U. S. Highway No. 2 bridge, the Standard Project Flood would be 1.5 feet lower than the June 1964 flood and 0.5 foot higher than the Intermediate Regional Flood.

* * *

FLOOD DAMAGES that would result from the Standard Project Flood would be extensive but not as devastating along Flathead River as those from the 1964 flood. The Intermediate Regional Flood would be comparatively minor.

* * *

MAIN FLOOD SEASON for the Flathead, Stillwater and Whitefish Rivers occurs during the months of April, May and June. Nearly all floods result from melting snow during this time, although some floods are caused or augmented by heavy rains.

* * *

VELOCITIES OF WATER during major floods range up to 6 feet per second in the channel of Flathead River. Velocities on the flood plain vary widely, depending on location, but generally are less than 3 feet per second.

Velocities of water during floods on the Stillwater River and Whitefish River range up to 3 feet per second in the channels. Velocities on the flood plain also vary widely but are generally less than 2 feet per second.

During the Standard Project Flood velocities would be extremely dangerous to life and property. In the channels, they would range up to 16 feet per second on Flathead River, 11 feet per second on the Stillwater River, and 3 feet per second on the Whitefish River. On the flood plains, maximum velocities would be 8, 3 and 2 feet per second on Flathead, Stillwater and Whitefish Rivers, respectively. Velocities greater than 3 feet per second combined with depths of 3 feet or greater are generally considered hazardous.

* * *

DURATION OF FLOODS on the Flathead River is relatively short because of regulation of the South Fork of the Flathead River by Hungry Horse Dam. During the extremely rare flood of June 1964, the Flathead River had a maximum rate of rise of about 1 foot per hour at the Columbia Falls gage and remained out of banks between 2 and 3 days.

Floods on the Stillwater and Whitefish Rivers often last for extended periods, occasionally in excess of two weeks. Both rivers generally rise and recede gradually. During the May 1948 flood, the estimated average rate of rise of Whitefish River and Stillwater River was one-quarter and 2 feet per day, respectively. Because of fragmentary information the May 1948 flood for the Stillwater and Whitefish Rivers will not be used for comparative purposes.

* * *

HAZARDOUS CONDITIONS would occur during large floods as a result of the rising streams and high velocities.

* * *

FLOOD DAMAGE PREVENTION MEASURES. Flood damage prevention measures within the limits of this study include several miles of levees along Flathead River, some levee development near the mouth of Stillwater River, realinements and improvements of the Flathead River channel and some main channel improvements on the Stillwater River and Whitefish River.

The South Fork of the Flathead River is regulated by Hungry Horse Dam, a Federal multi-purpose project completed in 1952. Usable capacity is 2,980,000 acre feet between elevations 3,560 (controlled spillway elevation) and 3,336 feet. Minimum operating level is 3,336 feet for on-site power generation (usable contents, 445,900 acre feet). Water is used for power production, flood control, irrigation and recreation.

* * *

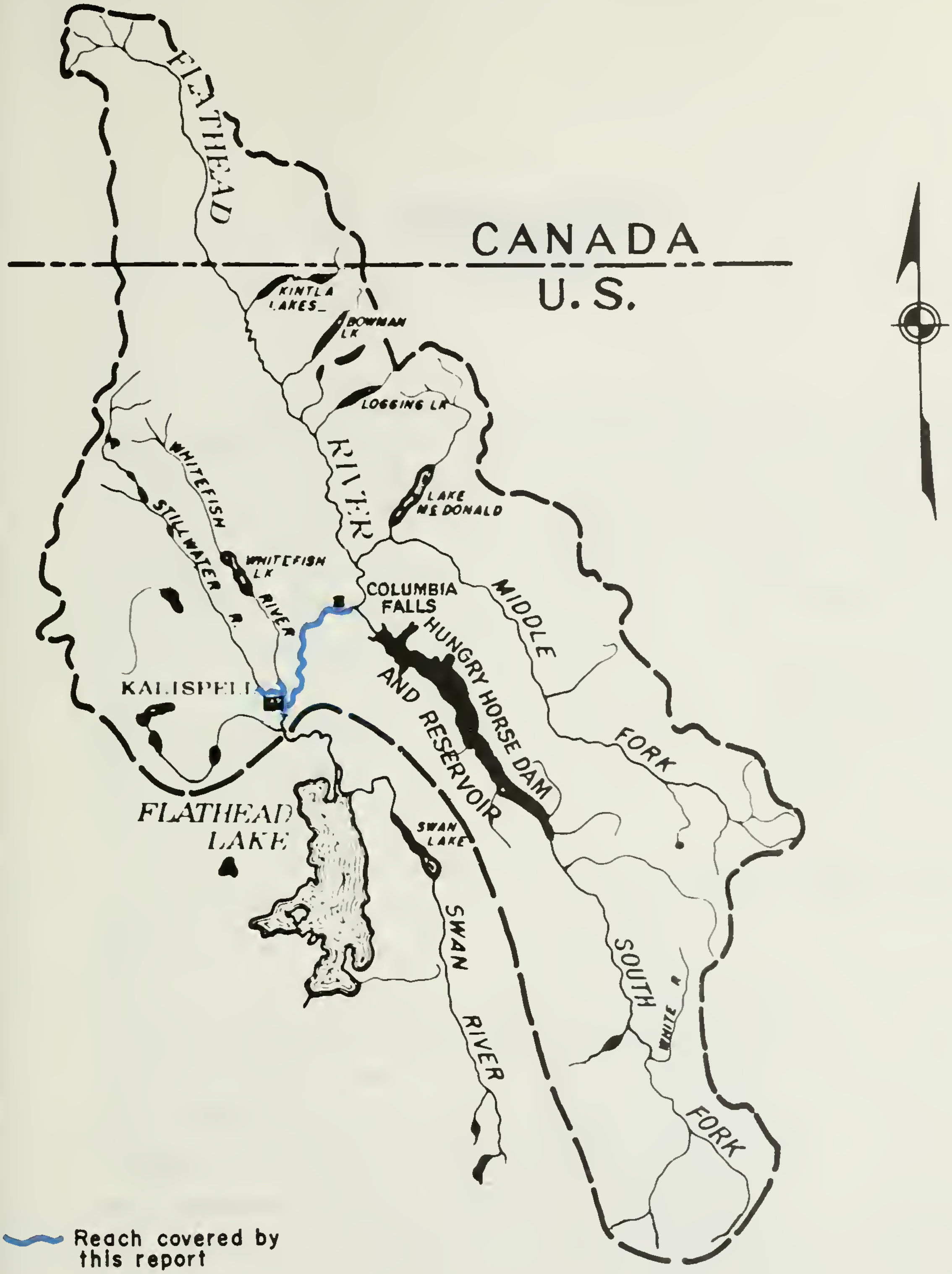
FUTURE FLOOD HEIGHTS that would be reached if the Intermediate Regional and Standard Project Floods occurred near Kalispell and Columbia Falls are shown in Table 1. The table gives the comparison of these floods and also shows the comparison with the June 1964 flood for Flathead River.

## TABLE 1

## RELATIVE FLOOD HEIGHTS FOR FLATHEAD RIVER

| Flood | Location | Mile Above Mouth | Estimated Peak Discharge cfs | Below June 1964 Flood feet |
|---|---|---|---|---|
| June 1964 | Columbia Falls (USGS Gage) | 143.0 | 176,000 | 0 |
| Intermediate Regional | | | 79,000 | 8.9 |
| Standard Project | | | 100,000 | 6.9 |
| June 1964 | U. S. Highway No. 2 Bridge | 129.2 | 176,000[1] | 0 |
| Intermediate Regional | | | 79,000[1] | 2.5 |
| Standard Project | | | 100,000[1] | 2.0 |

[1] Estimated.



CORPS OF ENGINEERS, U. S. ARMY
SEATTLE, WASHINGTON, DISTRICT

## FLATHEAD RIVER WATERSHED ABOVE KALISPELL

SCALE IN MILES
10 0 10 20 30 40 50

JUNE 1969

PLATE I

# GENERAL CONDITIONS
# AND
# PAST FLOODS

This section of the report is a history of floods on the Flathead, Stillwater and Whitefish Rivers near Kalispell and Columbia Falls in Flathead County, Montana. The portion of Flathead River studied extends from river mile 125.6 near Kalispell to river mile 147.6 upstream of Columbia Falls. The investigation of the Stillwater River covers the lower 5 miles. Whitefish River was studied from the mouth upstream to the county bridge at mile 2.8. Whitefish River joins the Stillwater River from the right bank at mile 125.4 at Kalispell. The drainage area of Flathead River upstream of the lower limits of this study is 5,212 square miles.

The Flathead River follows a meandering course through a broad flood plain over the reach covered by this investigation. The flood plain varies from 1 to 3 miles wide.

A suburban and rural area of about 18,700 acres along Flathead, Stillwater and Whitefish Rivers is in the flood plain in the study reach. Most of the important commercial and industrial establishments and the larger residential section of Kalispell and Columbia Falls are on high ground above flood danger. Days Acres and Evergreen, suburban communities of Kalispell, are partially in the flood plain. Residences in these communities have been flooded in the past. The narrow flood plain lands along the Stillwater and Whitefish Rivers are used for agricultural purposes or remain undeveloped. As the towns of Kalispell and Columbia Falls expand, a premium will be placed on flood plain lands that were formerly considered uneconomical for development.

The first records of river stage and discharge on the Flathead River at Columbia Falls date from May 1922 when the U. S. Geological Survey installed a wire-weight gage on the county road bridge at Columbia Falls.

Flood history searches developed information on the Flathead, Stillwater and Whitefish Rivers. Investigations were made following the floods of May 1948 and June 1964. Local residents were interviewed. Field investigations and office computations were made to supplement the early data and to develop the flood profiles for the largest recent known flood on the Flathead River that of June 9, 1964. A search was also made of newspaper files and historical documents. From these sources and gage records, it has been possible to develop a history of the known floods on Flathead River covering the past 75 years. Because of fragmentary records flood profiles for the May 23, 1948 flood were not developed for the Stillwater and Whitefish Rivers. A partial history has been developed for Stillwater and Whitefish Rivers.

# FLATHEAD RIVER
## GENERAL

### Settlement

The Flathead River valley was "Indian country" prior to the turn of the 19th Century. The early 1800's ushered in the fur traders. About 1810 the Northwest Fur Company established a temporary trading post north of Flathead Lake. Subsequently the Hudson Bay Company entered the scene, and the main activity was in fur trade well past the middle of the century.

In 1887 T. J. DeMers opened a general store in a tent and founded the town of Demersville on the west bank of Flathead River some 2.5 miles southeast of the site of Kalispell. At the head of all-year navigation for steamboats operating up the Flathead River from Flathead Lake, this town grew to more than 1,000 population by 1891, but nothing remains of it today. When the Great Northern Railway was built, the route missed Demersville. Residents of the town quickly moved to a new town site - Kalispell - on the railroad. Completion of the Great Northern hastened development of agricultural and lumbering in the area as markets became more accessible.

The first crops raised in the Flathead River valley were wheat and potatoes; these crops remain important in the area today. Nicholas Moon, profiting by experience in California, pioneered in irrigation agriculture. He made one of the first filings for water in 1885, appropriating water from Ashley Creek 1 mile west of Kalispell.

## Flood Damage Prevention Measures

Extensive efforts have been made by various Federal, State and local interests to control flooding and reduce flood damages in the vicinity of Kalispell. The principal flood control measures on the Flathead River within the limits of this report consist of several miles of levees along both banks of the river, channel improvements and realinements, bank protection and erosion control devices.

The South Fork of the Flathead River, a major tributary of Flathead River upstream of Columbia Falls, is regulated by Hungry Horse Dam, a Federal multi-purpose project completed in 1952. The regulation of the South Fork of the Flathead River during large floods reduces the extent and duration of flooding in the lower valley.

## Flood Warning and Forecasting Services

The U. S. Weather Bureau Airport Station of Kalispell is responsible for the dissemination of flood warnings and river forecasts for this area.

River forecasts are prepared by the Weather Bureau River Forecast Center, Portland, Oregon, in cooperation with the Corps of Engineers. During the active snowmelt season, forecasts are prepared daily by the Cooperative Columbia River Forecasting Unit, a cooperative effort of the Corps of Engineers and the U. S. Weather Bureau in Portland. When these forecasts indicate that high flows may be expected, the forecasts are immediately relayed to the Kalispell Weather Bureau office for dissemination to the public and other interested parties.

## The Stream and Its Valley

The Flathead River drainage area is approximately 5,280 square miles at the inlet of Flathead Lake. The Flathead River from its source north of the International Boundary Line flows southerly through Flathead Lake joining the Clark Fork near Dixon, Montana. The drainage basin of the Flathead River upstream from the city of Kalispell is 5,212 square miles and lies west of the Continental Divide in portions of Montana and British Columbia. Plate 1 shows the watershed and stream drainage system for the Flathead River above Kalispell, Montana.

Elevations within the basin range from 2,900 feet at Kalispell to over 10,000 feet at the Continental Divide. Major tributaries above Kalispell include: The Stillwater and Whitefish Rivers which will be discussed in later sections of this report; the South and Middle Forks which flow in a northwesterly direction and join the Flathead River about 3 and 6 miles, respectively, above the town of Columbia Falls.

The slope of the Flathead River from its source to Columbia Falls is very steep. In the study reach between Columbia Falls and Kalispell the slope varies from 5 to 7 feet per mile.

The Flathead River downstream of Columbia Falls flows through meandering channels in a flood plain varying from 1 to about 3 miles wide.

Pertinent drainage areas of Flathead River are given in Table 2.

## TABLE 2

## DRAINAGE AREAS IN WATERSHED OF FLATHEAD RIVER

| Stream | Location | Mile Above Mouth | Drainage Area sq. mi. |
|---|---|---|---|
| Flathead River | Inlet to Flathead Lake | 103.0 | 7,086 |
| | Columbia Falls | 143.0 | 4,484 |
| Stillwater River | | 12.0 | 394 |
| Whitefish River | | 8.0 | 170 |

## Developments in the Flood Plain

Plate 6 is an index map of the five sheets that show the flooded areas of Flathead, Stillwater and Whitefish Rivers. Plates 7 through 11 show the flood plain of Flathead River for the reach covered by this report. Except for development within the towns of Kalispell and Columbia Falls and a minor concentration of suburban development in the Days Acres and Evergreen communities there are only scattered developments elsewhere. Most of the flood plain is devoted to agricultural or related purposes.

United States Highway No. 2 crosses the flood plain and the Flathead River at river mile 129.2 in an east-west direction. The highway is subject to damage at various locations during Intermediate Regional and Standard Project Floods. During the June 1964 flood the highway was impassable in the Evergreen area and many county roads were inundated to depths of 4 feet.

## Bridges Across the Stream

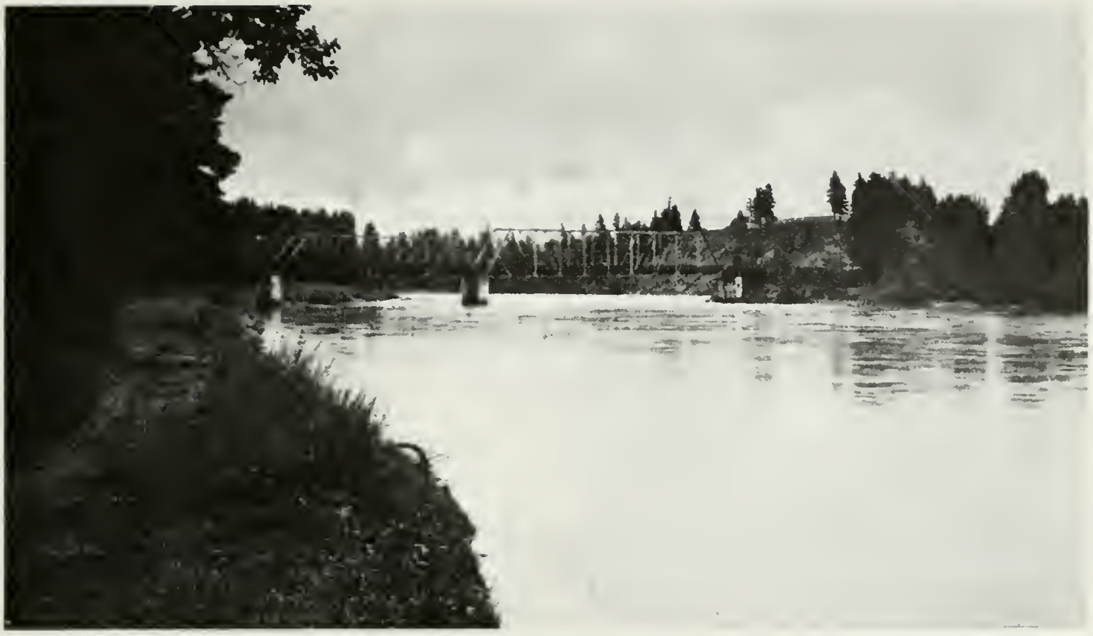
Four highway bridges cross the Flathead River in the reach included in this study. Table 3 lists pertinent elevations for these structures and shows their relation to the crest of the flood of June 1964 and the Intermediate Regional Flood. Figure 1 shows photographs of some of the bridges.

None of the bridges across the Flathead River are serious obstruction to stream overflow. All of the bridges are well above the crest of the June 1964 flood. Calculations and observations indicate head losses (defined in the GLOSSARY of this report) at these structures would be negligible.

## TABLE 3

## BRIDGES ACROSS FLATHEAD RIVER

| Mile Above Mouth | Identification | Stream Bed Elev. feet | Intermediate Regional Flood Crest Elev. feet | June 1964 Flood Crest Elev. feet | Underclearance | |
|---|---|---|---|---|---|---|
| | | | | | Elev. feet | Above June 1964 Flood feet |
| 127.8 | County Road | 2,865 | 2,912.5 | 2,915.0 | 2,924 | 9.0 |
| 129.2 | U. S. Highway No. 2 - High bridge, in excess of 40 feet above June 1964 flood | | | | | |
| 143.0 | County Road (Red Bridge) | 2,967 | 2,994.3 | 3,003.5 | 3,011 | 7.5 |
| 143.7 | State Highway 40 | 2,973 | 2,999.5 | 3,006.5 | 3,012 | 5.5 |



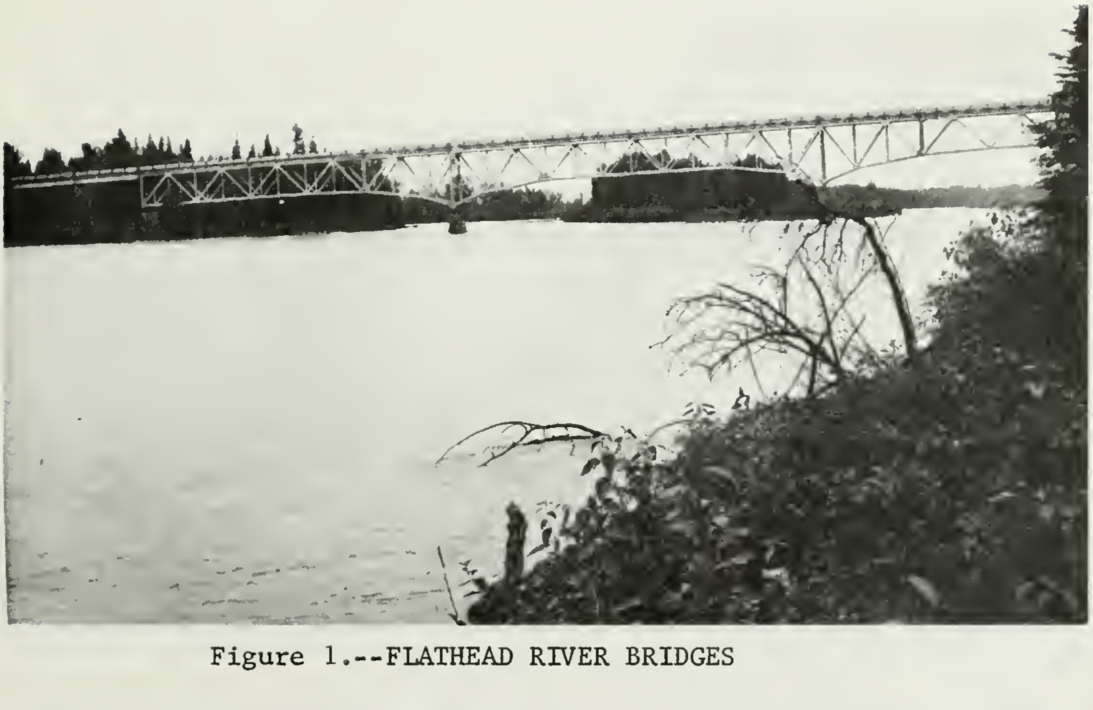


Figure 1.--FLATHEAD RIVER BRIDGES

Upper view is downstream side of Old Steel Bridge at mile 127.8. Lower view is downstream side of U. S. Highway No. 2 bridge at mile 129.2.

## Obstructions to Flood Flow

The effect of obstructions due to bridges or bridge approaches has been discussed in the previous paragraphs. There are no other significant obstructions to flows in the Flathead River reach included in this study.

# FLOOD SITUATION

## Flood Records

The recording of river stages on the Flathead River within the limits of this study began at Columbia Falls in May 1922 when the U. S. Geological Survey installed a wire-weight gage 200 feet upstream from the present gaging station. The present gaging station was established in November 1928, on the right bank 200 feet downstream from the county road bridge at Columbia Falls. A continuous water-stage recorder is presently installed at this station.

Records from the gaging station, Flathead River at Columbia Falls, and several other stations located on tributaries of Flathead River upstream from Columbia Falls have been analyzed and used in the basic studies for this report.

## Flood Stages and Discharges

Discharges above 67,000 cubic feet per second at Columbia Falls gage are estimated to cause flooding on Flathead River within the study area. Table 4 lists crest stages and peak discharges for the known floods which have exceeded 67,000 cubic feet per second at the Columbia Falls gage. Table 5 lists the highest ten peak discharges of Flathead River at Columbia Falls in order of magnitude. The list of floods contained in Table 4 may not include all the floods which have occurred on Flathead River within the limits of this study. Although no instances are known, it is possible that flooding may have occurred as a result of high inflow from the area downstream of Columbia Falls.

## Flood Occurrences

Plate 2 shows crest stage and years of occurrence for known floods on Flathead River at Columbia Falls gage which have exceeded 67,000 cubic feet per second. Discharges above 67,000 cubic feet per second at Columbia Falls gage are estimated to cause flooding on Flathead River within the limits of this study.

### TABLE 4

### FLATHEAD RIVER AT COLUMBIA FALLS, MONTANA

### FLOOD CREST ELEVATIONS[1/]

### 1894 - 1967

The table includes all known peak discharges above 67,000 cubic feet per second and corresponding stage heights at the U. S. Geological Survey gaging station, Flathead River at Columbia Falls, located on the right bank 200 feet downstream from the county road bridge at Columbia Falls at river mile 143.0. Drainage area = 4,464 square miles. Zero of gage is 2,977.67 feet mean sea level, datum of 1929, supplementary adjustment of 1947 (levels by U. S. Army Corps of Engineers).

| Date of Crest | Gage Height Stage feet | Peak Discharge cfs |
|---|---|---|
| June 1894 | 22.70[2] | 142,000 |
| June 5, 1922 | 16.94[2] | 82,200[2] |
| June 1, 1923 | 17.52[2] | 88,000[2] |
| May 27, 1928 | 18.82[2] | 101,000[2] |
| May 24, 1929 | 14.44 | 69,700 |
| May 22, 1932 | 16.46 | 89,800 |
| June 16, 1933 | 17.63 | 91,200 |
| May 24, 1935 | 15.28 | 71,000 |
| May 15, 1936 | 15.40 | 71,800 |
| May 27, 1938 | 15.30 | 70,400 |
| May 29, 1946 | 15.68 | 68,400 |
| May 9, 1947 | 17.27 | 83,700 |
| May 23, 1948 | 19.08 | 102,000 |
| June 22, 1950 | 16.16 | 74,600 |
| May 12, 1951 | 15.50 | 69,000 |
| May 20, 1954 | 15.57 | 69,600[3] |
| June 9, 1964 | 25.58 | 176,000[3] |

[1] Discharges above 67,000 cubic feet per second (present stage height 15.37 feet) at the gage, Flathead River at Columbia Falls, are estimated to cause flooding of Flathead River within the limits of this study. Some shift in the stage-discharge relationship has occurred since installation of the gage as indicated by those floods with crest stage heights less than 15.37 feet.

[2] Floods occurred prior to installation of the present gaging station. The 1894 peak discharge was estimated by U. S. Geological Survey from high water marks. The discharges shown for the 1922-23 events were observed and are estimated to be near the peak flow (peak discharges are unknown). The gage heights listed for the 1922, 1923 and 1928 floods are based on present gage rating.

[3] Regulated by Hungry Horse Dam.

## TABLE 5

## HIGHEST TEN KNOWN FLOODS IN ORDER OF MAGNITUDE

## FLATHEAD RIVER AT COLUMBIA FALLS

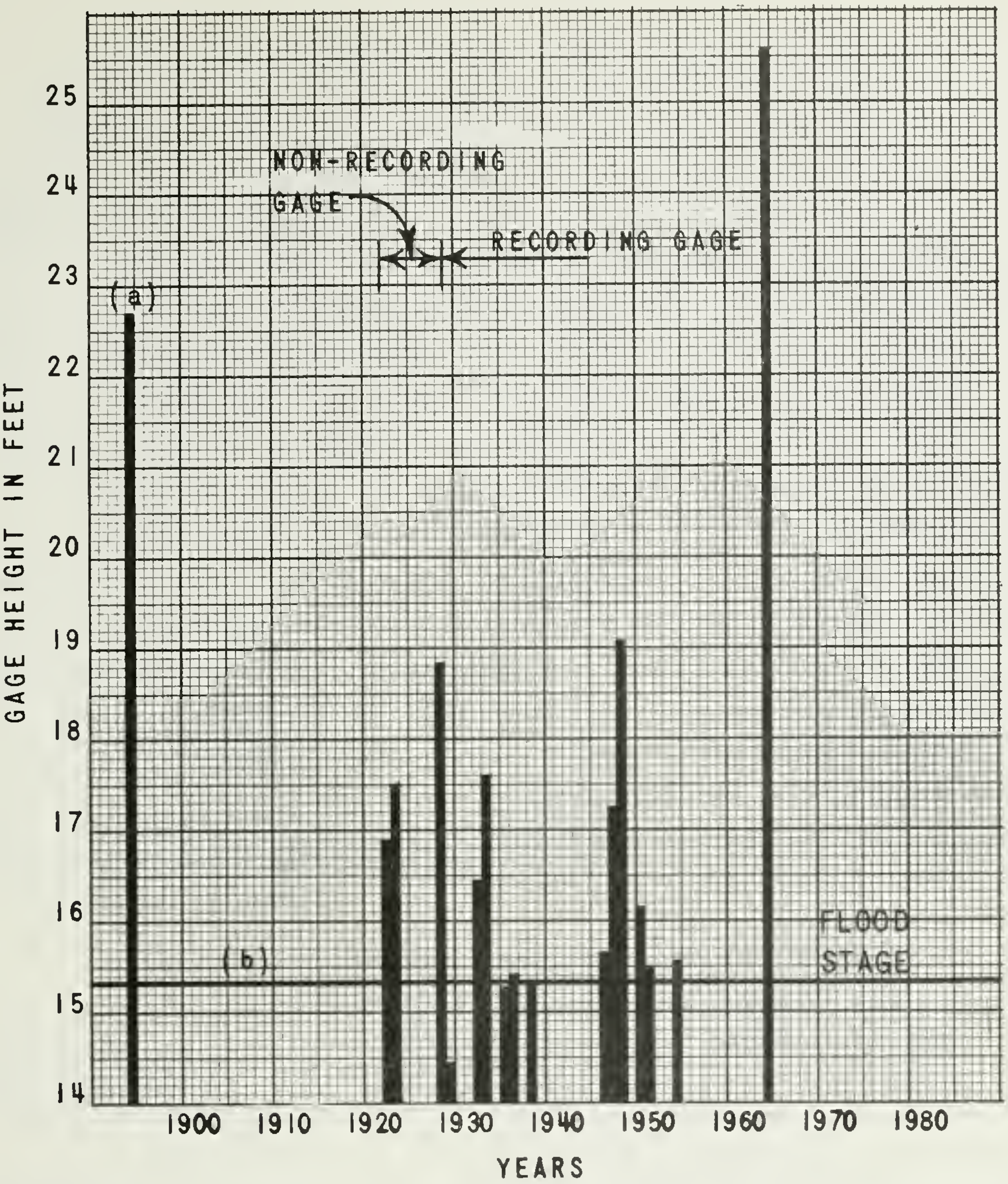
| Order No. | Date of Crest | Gage Height feet | Estimated Peak Discharge cfs |
|---|---|---|---|
| 1 | June 9, 1964 | 25.58 | 176,000[1] |
| 2 | June 1894 | 22.70 | 143,000[2] |
| 3 | May 23, 1948 | 19.08 | 102,000 |
| 4 | May 27, 1928 | 18.82 | 101,000 |
| 5 | June 16, 1933 | 17.63 | 91,200 |
| 6 | May 22, 1932 | 16.46 | 89,800 |
| 7 | June 1, 1923 | 17.52 | 88,000[3] |
| 8 | May 9, 1947 | 17.27 | 83,700 |
| 9 | June 5, 1922 | 16.94 | 82,200[3] |
| 10 | June 22, 1950 | 16.16 | 74,600 |

---

[1] Flood regulated by Hungry Horse Dam.

[2] Estimated by U. S. Geological Survey from high water marks.

[3] Maximum discharge observed (peak discharge unknown).
Stage heights based on present gage rating.



NOTES: (a) Stage estimated by U.S. Geological Survey from high water marks.

(b) Discharges above 67,000 cfs (present gage height 15.37') estimated to cause flooding of Flathead River within the limits of the study. Refer to Note I of Table 4 for explanation of stage heights less than 15.37 FEET.

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## FLOODS ABOVE BANKFULL STAGE

FLATHEAD RIVER
AT
COLUMBIA FALLS, MONTANA

JUNE 1969

PLATE 2

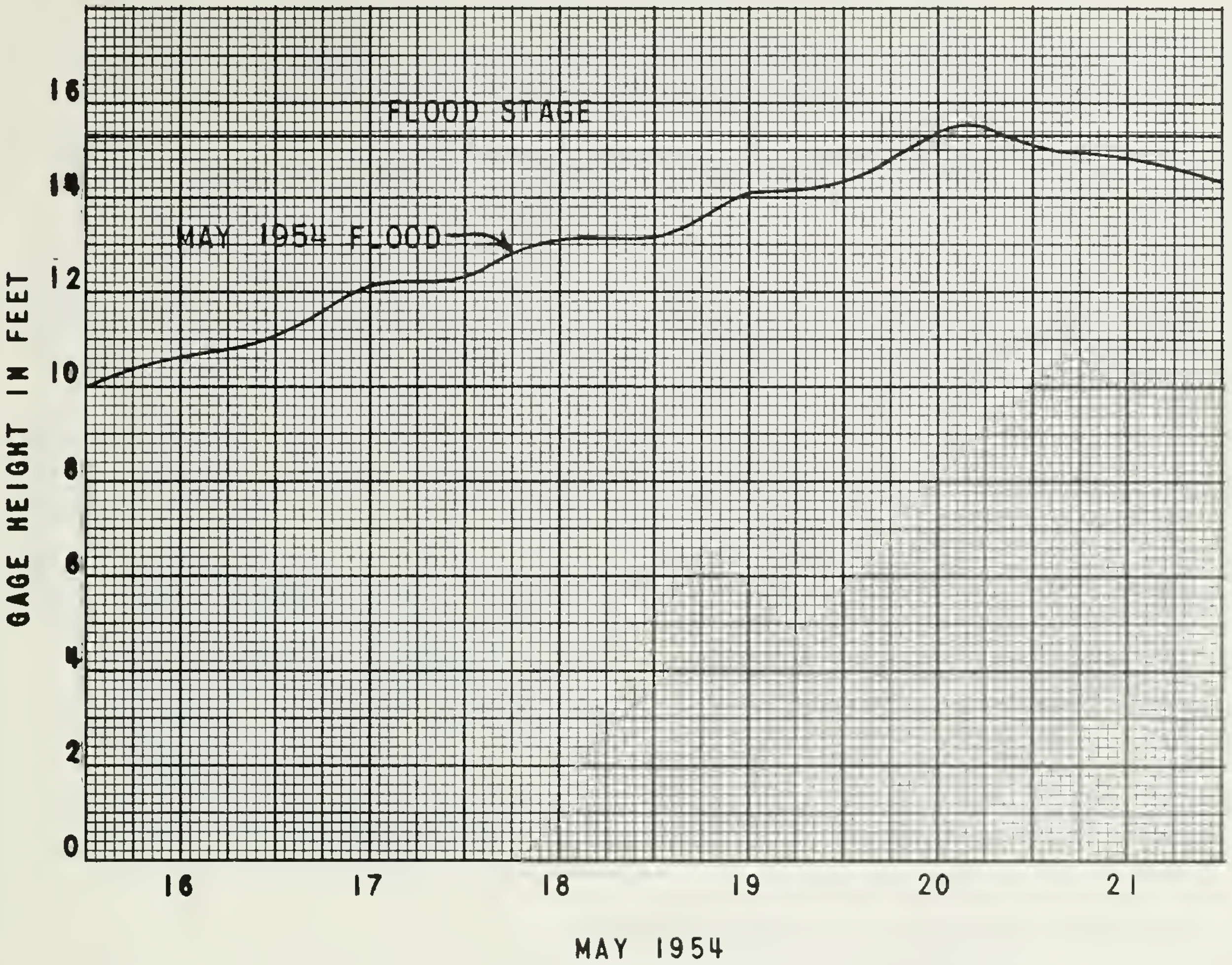
## Duration and Rate of Rise

Plates 3 and 4 show stage hydrographs for Flathead River at the stream gaging station, Flathead River at Columbia Falls, for the regulated floods of May 1954 and June 1964, respectively. During the 1954 flood, the river rose to its crest at Columbia Falls in 5 days at an average rate of 1.2 feet per day with a maximum rate of 2.4 feet per day and remained above flood stage (67,000 cubic feet per second) about 10 hours. During the 1964 flood, the river rose to its crest at Columbia Falls in 1½ days at an average rate of 0.5 foot per hour with a maximum rate of 1 foot per hour and remained above flood stage about 2½ days. During the unregulated May 1948 flood, the Flathead River rose to its crest at Columbia Falls in about 7 days at an average rate of rise of 1.5 feet per day with a maximum rate of rise of about 3 feet per day and remained above flood stage (67,000 cubic feet per second) about 12 days.

The following crest stage elevations of Flathead River near the highway bridge (U. S. Highway No. 2) northeast of Kalispell were established from high water marks: May 1948 - elevation 2918.70; June 1964 - elevation 2920.28.

## Velocities

During the June 1964 flood, it is estimated that velocities in the channel of Flathead River in the vicinity of Kalispell ranged up to 8 feet per second. Overbank velocities ranged up to 3 feet per second.



**NOTES:**

1. Stream gage at river-mile 143.
2. Zero of gage is 2977.67 feet above mean sea level.

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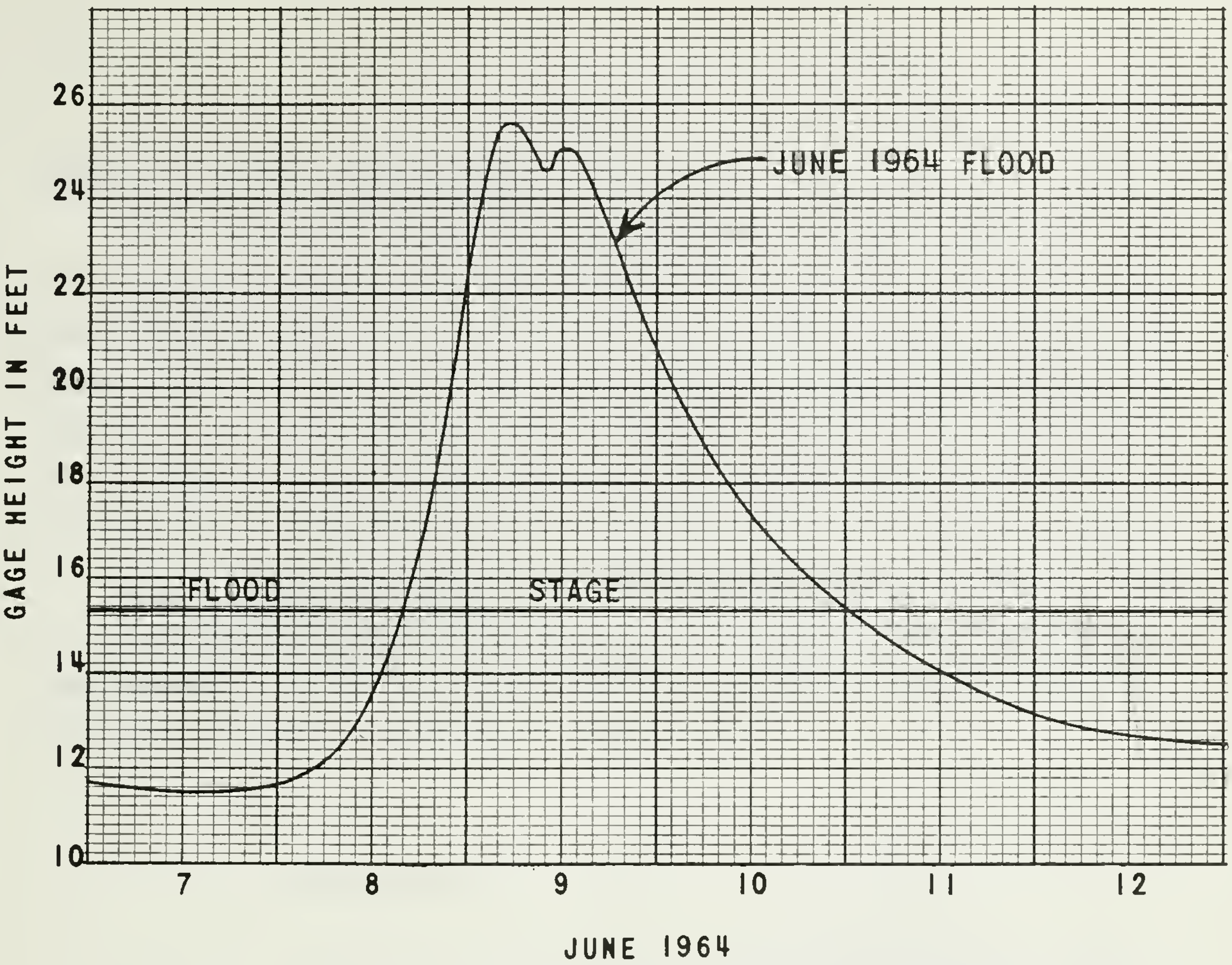
## STAGE HYDROGRAPH

FLATHEAD RIVER
AT
COLUMBIA FALLS, MONTANA
JUNE 1969

PLATE 3



NOTES:

1. Stream gage at river mile 143.
2. Zero of gage is 2977.67 feet above mean sea level.

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STAGE HYDROGRAPH

FLATHEAD RIVER
AT
COLUMBIA FALLS, MONTANA
JUNE 1969

PLATE 4

Flooded Areas and Flood Profiles

Plates 7 through 11 show the areas along the Flathead River in the study reach that would be inundated by the Intermediate Regional Flood and also by the Standard Project Flood. The actual limits of these overflow areas on the ground may vary from those shown on the topographic map because the scale of the map and limited topography do not permit precise plotting of the flooded area boundaries.

Plates 12 through 14 show the high water profiles for the June 1964 flood. Also shown are the profiles for the Intermediate Regional Flood and the Standard Project Flood discussed on pages 40 through 46 of this report.

## STILLWATER RIVER AND WHITEFISH RIVER

### The Streams and Their Valleys

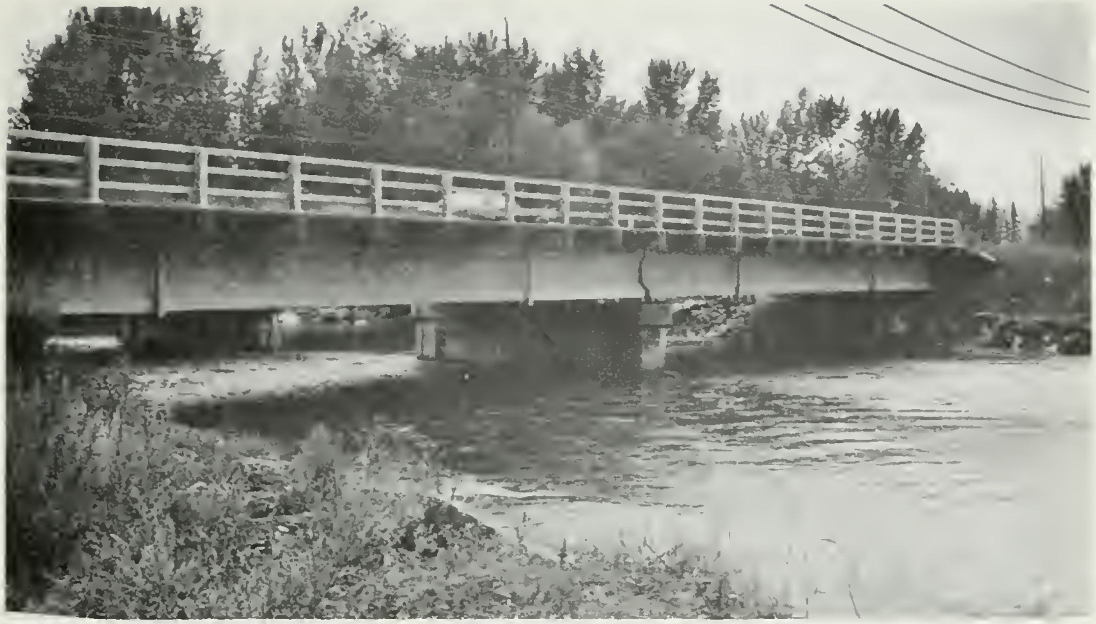
The Stillwater and Whitefish Rivers originate in the Flathead National Forest. The rivers are contiguous and flow parallel in a southeasterly direction to Kalispell. These drainage areas are mostly rolling plateau lands extensively developed for dry farming. The Whitefish River enters the Stillwater River at about river mile 3.0. Plate 1 is a drainage area map which shows the streams in the Flathead River Basin.

### Developments in the Flood Plain

Flood plains along these streams are shown on Plates 7 and 8. Development in the flood plains is limited to a few residences and small commercial establishments near U. S. Highway No. 2 ("The Strip"). The major portion of these flood plain lands upstream of the study reach are used for agricultural purposes.

### Bridges Across the Streams

A total of 10 bridges cross the Stillwater and Whitefish Rivers within the study reach. Five bridges cross each river. Views of some of the bridges are given in Figures 2 and 3. Table 6 lists pertinent elevations for these bridges and shows the relation to the crest of the Intermediate Regional and Standard Project Floods. Several of these bridges are severe obstructions to flood flows. Debris collects on the piling of these structures reducing the carrying capacity of the channel. Backwater from this debris causes overbank flooding upstream. Failure of any one of these bridges would release a wave of water and debris causing extremely hazardous conditions downstream.



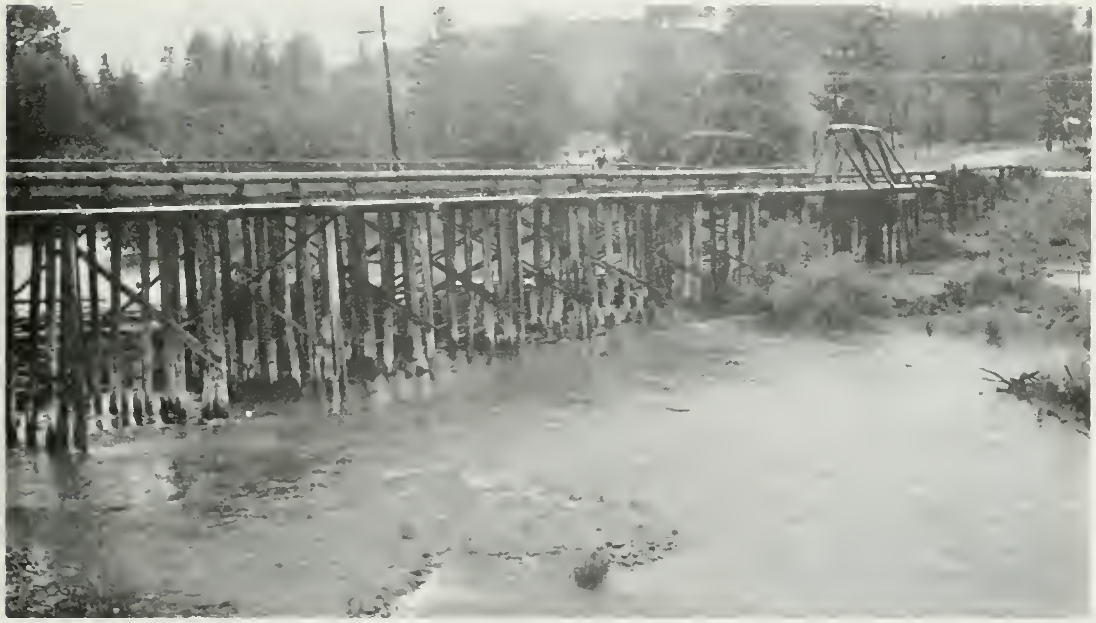


Figure 2.--STILLWATER RIVER BRIDGES

Upper view is upstream side of the U. S. Highway No. 2 twin bridges at mile 2.95. Lower view is downstream side of 7th Avenue E.N. bridge at mile 4.45.

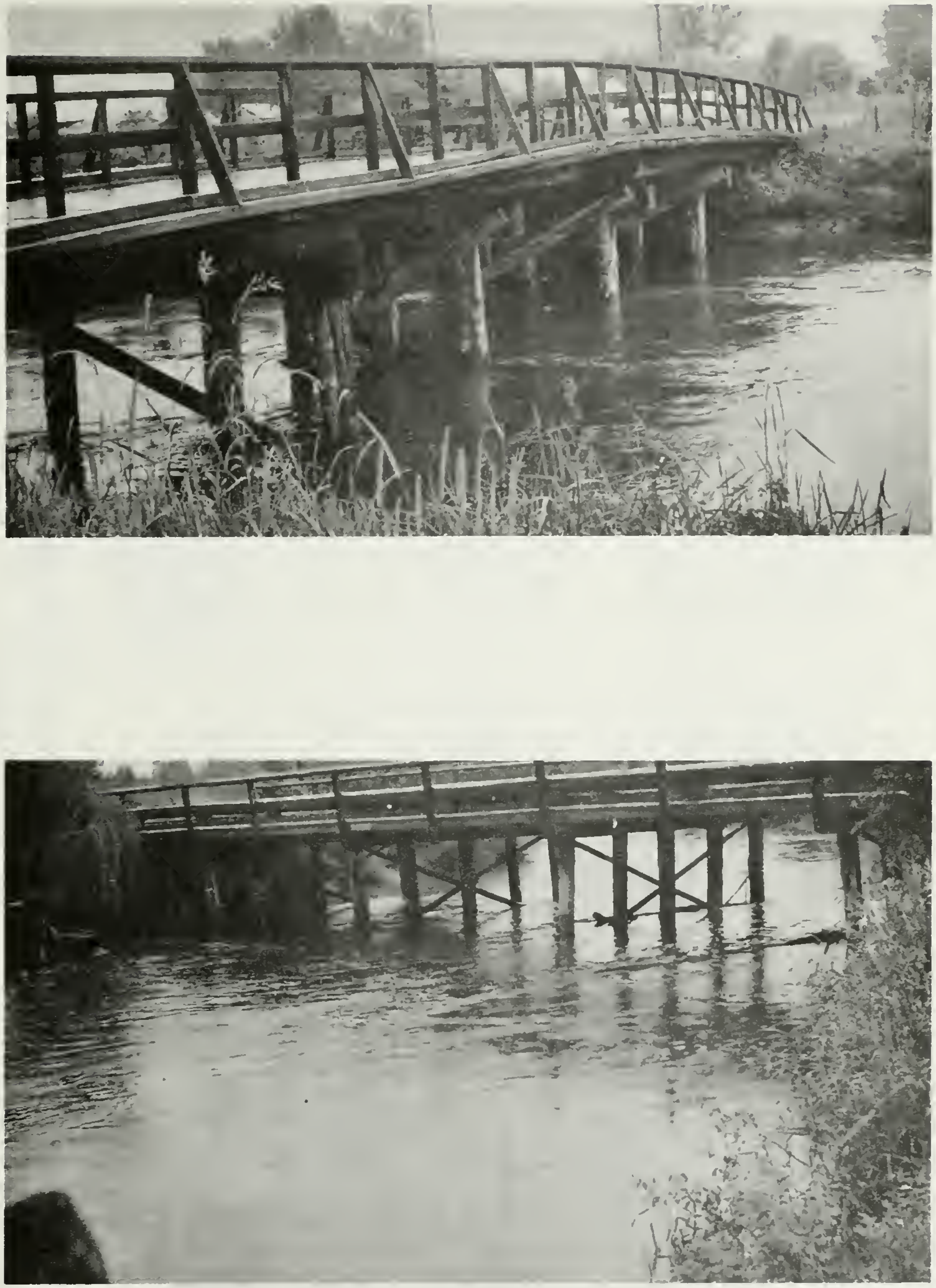


Figure 3.--WHITEFISH RIVER BRIDGES

The upper view is downstream side of county road bridge at mile 0.15. Lower view is downstream side of county road bridge at mile 2.85.

## TABLE 6

## BRIDGES ACROSS STILLWATER AND WHITEFISH RIVERS

| Mile Above Mouth | Identification | Stream Bed Elev. feet | Floor Elev. feet | Intermediate Regional Flood Crest feet | Standard Project Flood Crest feet | Underclearance Intermediate Regional Flood Elev. feet | Underclearance Intermediate Regional Flood Above feet |
|---|---|---|---|---|---|---|---|
| | STILLWATER RIVER | | | | | | |
| 2.30 | Conrad Drive | 2894.5 | 2916.0 | 2908.8 | 2909.8 | 2914.5 | 5.7 |
| 2.95 | U. S. Highway No. 2 (twin bridges) | 2896.5 | 2917.5 | 2910.5 | 2911.5 | 2912.5 | 2.0 |
| 3.40 | Great Northern Railway | 2901.5 | 2925.2 | 2914.5 | 2917.0 | 2921.2 | 6.7 |
| 4.15 | County Road | 2918.0 | 2932.0 | 2929.0 | 2931.5 | 2930.0 | 1.0 |
| 4.45 | 7th Avenue E. N. | 2923.0 | 2947.8 | 2936.0 | 2939.5 | 2946.2 | 10.2 |
| | WHITEFISH RIVER | | | | | | |
| 0.15 | County Road | 2899.7 | 2912.5 | 2910.5 | 2911.5 | 2911.3 | 0.8 |
| 0.50 | West Wood Lane | 2901.0 | 2913.8 | 2911.5 | 2912.0 | 2912.5 | 1.0 |
| 0.80 | Great Northern Railway | 2901.2 | 2922.0 | 2912.5 | 2913.2 | 2918.2 | 5.7 |
| 1.70 | West Evergreen Drive | 2901.0 | 2915.3 | 2913.5 | 2914.5 | 2914.0 | 0.5 |
| 2.85 | County Road | 2905.3 | 2919.5 | 2916.2 | 2916.8 | 2917.8 | 1.6 |

## Flood Damage Prevention Measures

The flood damage prevention measures on both rivers are comparatively minor. Some levees and channel improvements have been constructed near the mouth of Stillwater River and minor channel improvements have been made on the Whitefish River.

## Flood Records - Stillwater River

No record of Stillwater River stage is available within the limits of this study; however, records of river stages and discharges on the Stillwater River were maintained by the U. S. Geological Survey during the periods September 1906-June 1907, April-August 1922, and June 1928-September 1950. Prior to November 1930, a staff gage was located at the highway bridge 5 miles north of Kalispell. In November 1930 a water-stage recorder was installed at a new gaging station located 600 feet downstream from the highway bridge near river mile 12. Recording of streamflows was discontinued in September 1950. A staff gage still exists at this location and is occasionally used for streamflow measurements.

## Flood Records - Whitefish River

No record of Whitefish River stage is available within the limits of this study; however, records of river stage and discharges on the Whitefish River near river mile 8.0 were maintained by the U. S. Geological Survey during the periods November-December 1906 and July 1928-September 1950. Prior to October 16, 1930, a staff gage was maintained at the gaging station. A water-stage recorder was installed in October 1930 and maintained until September 1950 when the station was discontinued.

## Flood Stage and Discharge

Discharges above 1,800 cubic feet per second at the Stillwater River gage and above 840 cubic feet per second at the Whitefish River gage are estimated to cause flooding downstream. Flood stages of the Stillwater River near the mouth may vary considerably because of backwater from the Flathead River. Table 7 lists discharges at the gage, Stillwater River near Whitefish, which have exceeded 1,800 cubic feet per second. Table 8 lists discharges at the gage, Whitefish River near Kalispell, which have exceeded 840 cubic feet per second.

## Flood Occurrence

The investigation of the U. S. Geological Survey streamflow records indicates that Stillwater River and Whitefish River experienced discharges in excess of 1,800 cubic feet per second and 840 cubic feet per second (estimated flood discharge) about half of the 22 years of streamflow record. Future flood occurrences on both rivers are expected to follow this pattern.

## Duration and Rate of Rise

Plate 5 shows discharge hydrographs on Stillwater River and Whitefish River at the gaging stations during the May 1948 flood. Conditions at these gaging stations are believed to be indicative of the duration and rate of rise that occurred on both rivers within the limits of this study. During the May 1948 flood both the Stillwater River and the Whitefish River rose gradually to crest stage. On the Stillwater River, the rise lasted 5 days while a considerable longer 9-day rise occurred on

## TABLE 7

## STILLWATER RIVER NEAR WHITEFISH, MONTANA

## PEAK FLOOD DISCHARGES ABOVE 1,800 CUBIC FEET PER SECOND[1]

## 1929 - 1950[2]

The table below lists all known floods with peak discharges above 1,800 cubic feet per second at the U. S. Geological Survey gaging station 600 feet downstream of the highway bridge near river mile 12.0. Drainage area = 394 square miles.

| Date of Discharge | Discharge cfs |
|---|---|
| May 16, 1932 | 1910 |
| June 2-5, 1933 | 1930 |
| April 28, 1934 | 2680 |
| May 26-27, 1935 | 2220 |
| April 23, 1943 | 2580 |
| May 12-13, 1947 | 3200 |
| May 26, 1948 | 4320 |
| May 17, 1949 | 2650 |
| May 19, 1950 | 2690 |

[1] Discharges in excess of 1,800 cubic feet per second are estimated to cause flooding downstream of the gaging station. The value is somewhat arbitrary because of inflow from Whitefish River and backwater from Flathead River which also affect flooding of the lower Stillwater River.

[2] Prior to November 1930, the gage was located on highway bridge 5 miles north of Kalispell. Gage was discontinued in 1950.

## TABLE 8

## WHITEFISH RIVER NEAR KALISPELL, MONTANA

## PEAK FLOOD DISCHARGES ABOVE 840 CUBIC FEET PER SECOND[2]

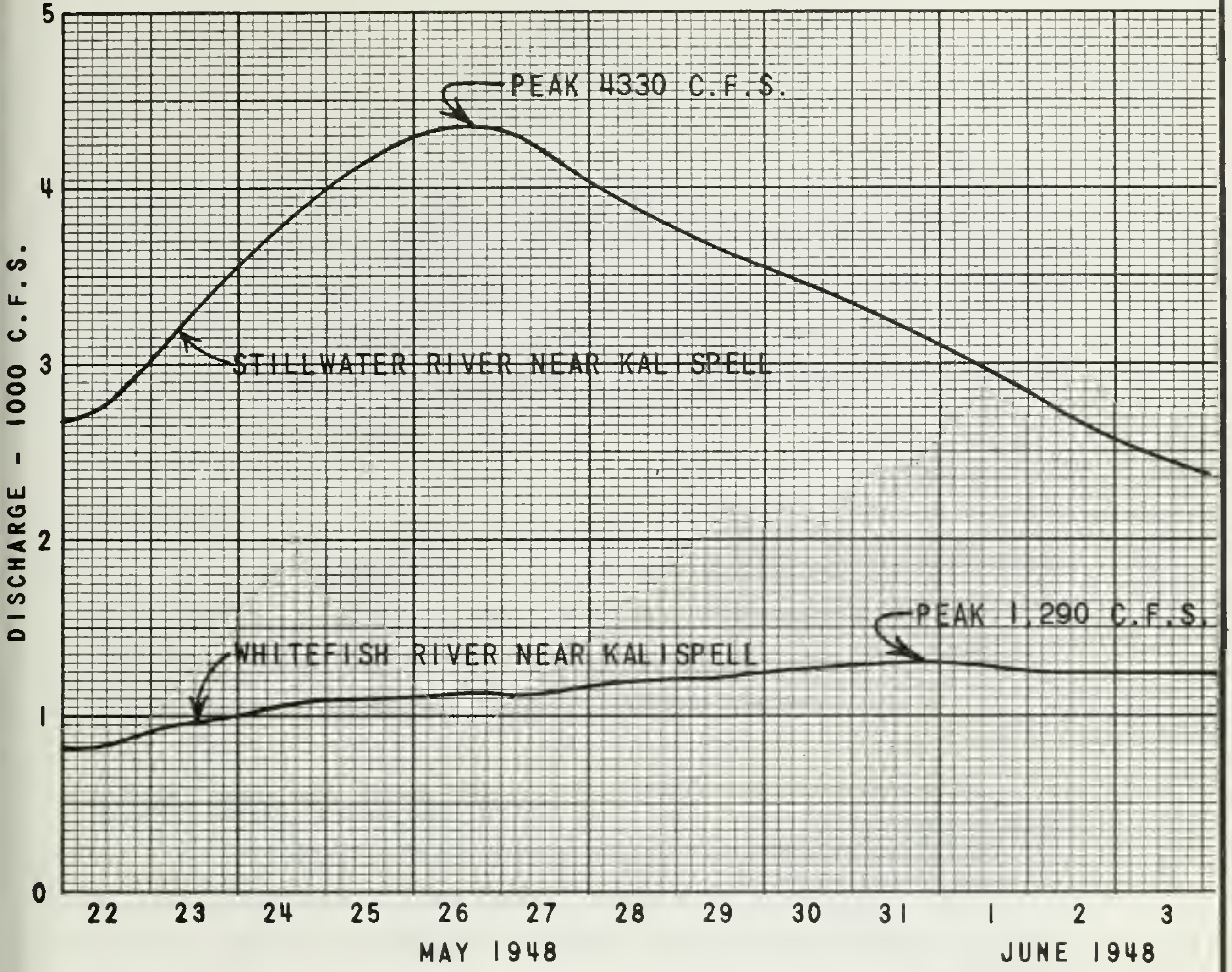
## 1929 - 1950[1]

The table below lists all known floods with discharges above 840 cubic feet per second at the U. S. Geological Survey gaging station located 8 miles upstream from the mouth of Whitefish River. Drainage area = 170 square miles.

| Date of Discharge | Discharge cfs |
|---|---|
| June 3-5, 1932 | 1230 |
| June 17-18, 1933 | 1140 |
| May 1, 1934 | 982 |
| June 16, 1935 | 905 |
| May 17, 1936 | 856 |
| May 31-June 3, 1946 | 1110 |
| May 3, 1947 | 1160 |
| May 3, 1948 | 1280 |
| May 19, 1949 | 977 |
| June 25, 1950 | 1250 |

[1] Gage was discontinued in 1950.

[2] Discharges in excess of 840 cubic feet per second are estimated to cause flooding downstream of the gaging station.



**NOTE:** Flooding on Stillwater and Whitefish Rivers within the study limits is estimated to occur when discharges exceed 1,800 c.f.s. and 840 c.f.s. at the gaging stations on Stillwater and Whitefish Rivers.

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## DISCHARGE HYDROGRAPH

STILLWATER RIVER NEAR WHITEFISH
AND
WHITEFISH RIVER NEAR KALISPELL
MONTANA

JUNE 1969

the Whitefish River. The average rates of rise of Stillwater River and Whitefish River during this flood were about 2 feet per day and ¼ foot per day, respectively. Both rivers remained above flood stage in excess of two weeks. Duration and rate of rise of Stillwater River near the mouth may vary considerably because of backwater from Flathead River.

## Velocities

No information is available regarding the velocities of Stillwater River and Whitefish River during past floods. Velocities near the mouth of Stillwater River may vary considerably because of backwater from the Flathead River.

## Flooded Areas and Flood Profiles

Plates 7 and 8 show the areas along the Whitefish and Stillwater Rivers in the study reach that would be inundated by the Intermediate Regional Flood and also by the Standard Project Flood. The actual limits of these overflow areas on the ground may vary from those shown on the topographic map because the scale of the map and limited topography do not permit precise plotting of the flooded area boundaries.

Plate 15 shows the high water profile for the Intermediate Regional and the Standard Project Floods discussed on pages 40 through 46 of this report.

No flood of record is shown for the Stillwater or Whitefish Rivers because of insufficient data.

# FLOOD DESCRIPTIONS

Following are descriptions of known large floods that have occurred in the vicinity of Kalispell and Columbia Falls, Montana. Large floods occurred on the Flathead, Stillwater and Whitefish Rivers during May 1948; however, no known flooding occurred on either Stillwater River or Whitefish River upstream of Kalispell during the June 1964 flood.

## June 9, 1964

The flood of June 1964 on the Flathead River was produced by an intense rainstorm located throughout the north-central Rocky Mountains. Low barometric pressures immediately prior to the storm caused an inflow of winds from the east and northeast and moisture-laden winds from the south. As these winds converged and rose over the Continental Divide, extremely large rainfall amounts were deposited. During a 30-hour period on June 7th and 8th, rainfall in excess of 15 inches occurred in some areas of the Flathead Basin. The rainfall and warmer temperatures caused snowmelt during this period that added a secondary component to the flooding. Conditions in the Stillwater and Whitefish Basins were less severe during this storm because of their greater distance from the storm center and lower elevations throughout these basins.

Following is an excerpt from the Hungry Horse News, Columbia Falls, Montana, concerning the 1964 flood:

June 12, 1964

> "An estimated 2,500 of the Flathead's 34,000 residents had homes damaged. Most are in the Evergreen and Days Acres on Kalispell's east side.
>
> "In Columbia Falls count of families with damaged or lost homes totals 57 with 250 persons in and near this community of 2,500 affected.
>
> "Total estimate of Flathead flood damage is $50 million."

Typical flooding conditions near the cities of Kalispell and Columbia Falls are shown in Figures 4 through 9.

May 1948

The flood of May 1948 on the Flathead, Stillwater and Whitefish Rivers was primarily a snowmelt flood, although some thunderstorm activity contributed and probably caused the high crest stages that occurred during the flood. Below average temperatures prevailed throughout the region prior to May 15th permitting an unseasonable buildup of the snowpack. About May 15th, temperatures increased abruptly throughout the area with maximum daily temperatures during the following week ranging near 70 degrees. (On May 21st a temperature of 80 degrees was recorded at Kalispell.)

Thunderstorm activity occurred at scattered points throughout the Flathead Basin during the flood period. As an example, rainfall amounts of 4.31 and 1.00 inches were measured at Kalispell and Summit, respectively, during the period May 19-23.

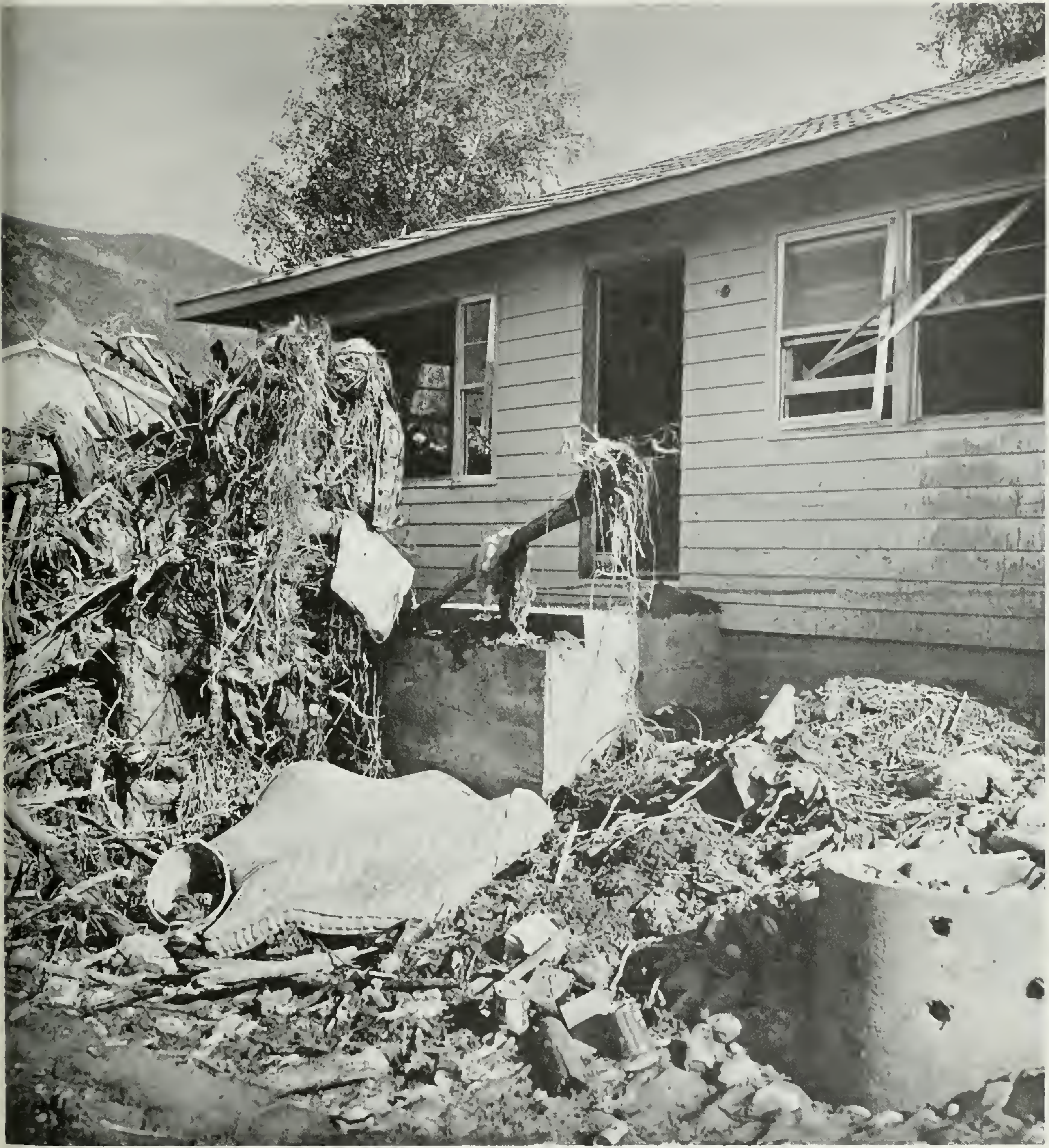


Figure 4.--NEW HOME DAMAGED AT COLUMBIA FALLS

On June 8th and 9th the flood put 4 feet of water and silt into recently remodelled home. (Photo courtesy of Mel Ruder, Editor, Hungry Horse News.)

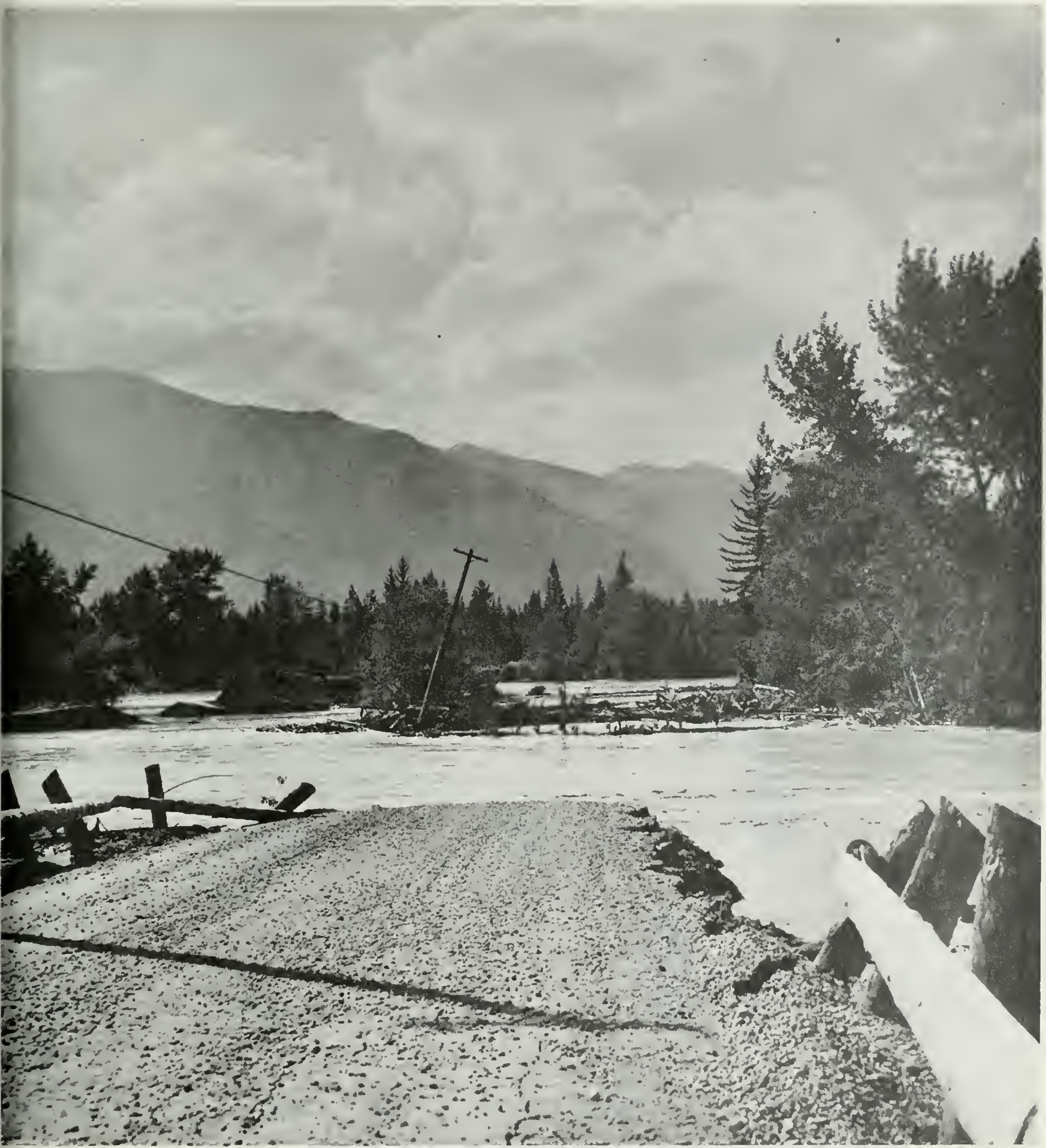


Figure 5.--EAST END OF RED BRIDGE APPROACH NEAR COLUMBIA FALLS

County crews worked hard and fast and restored this approach to the bridge. (Photo courtesy of Mel Ruder, Editor, Hungry Horse News.)

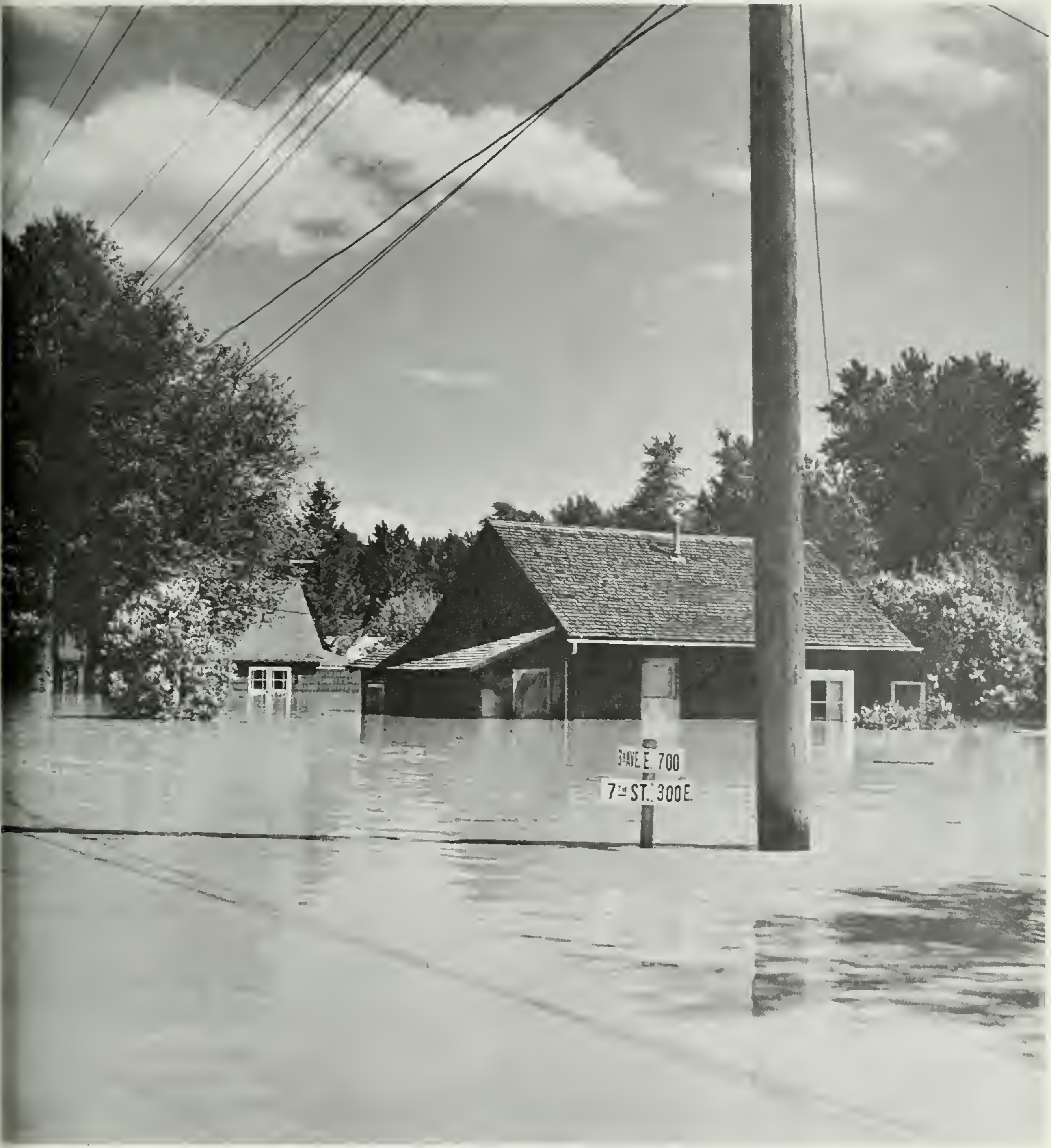


Figure 6.--THIRD AVENUE EAST AT SEVENTH STREET, COLUMBIA FALLS

Water was silt brown. (Photo courtesy of Mel Ruder, Editor, Hungry Horse News.)

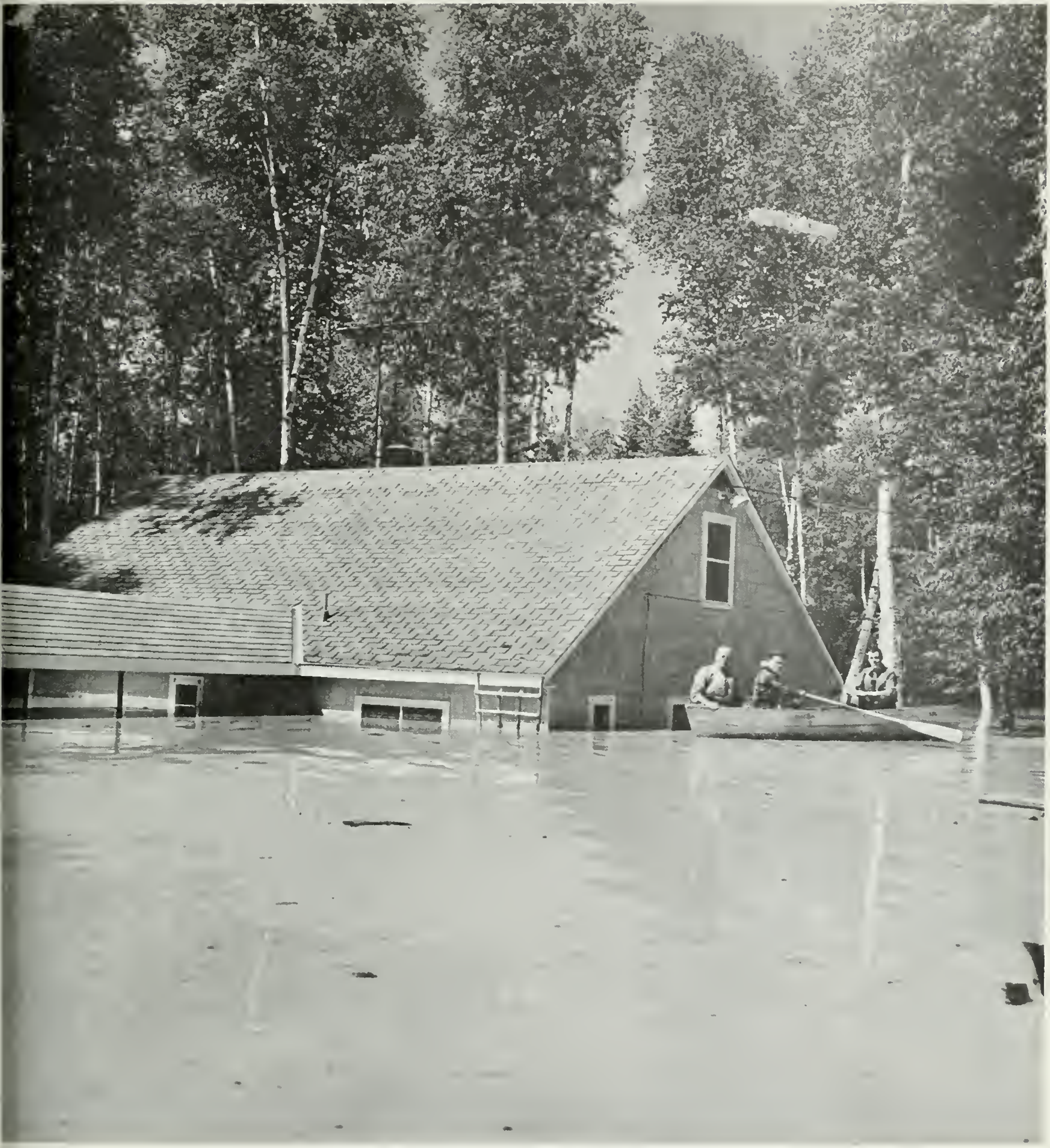


Figure 7.--FLOODED RESIDENCE

Mr. L. W. McNeil's home on flat was flooded nearly to eaves. (Photo courtesy of Mel Ruder, Editor, Hungry Horse News.)

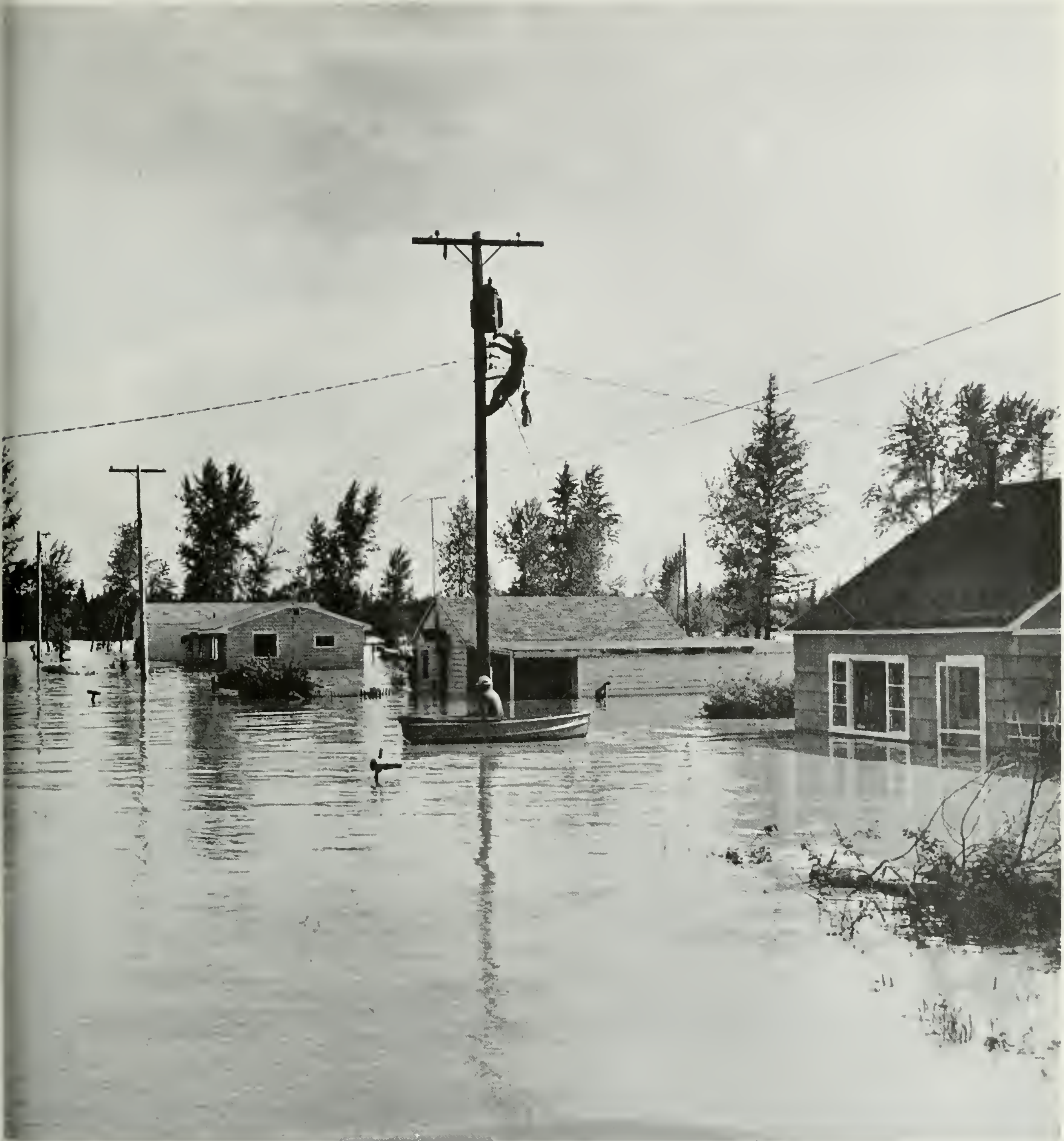


Figure 8.--UTILITY CREWS AT WORK

Pacific Power and Light crew at work as water started to drop at homes near Silver Bridge, Columbia Falls. (Photo courtesy of Mel Ruder, Editor, Hungry Horse News.)

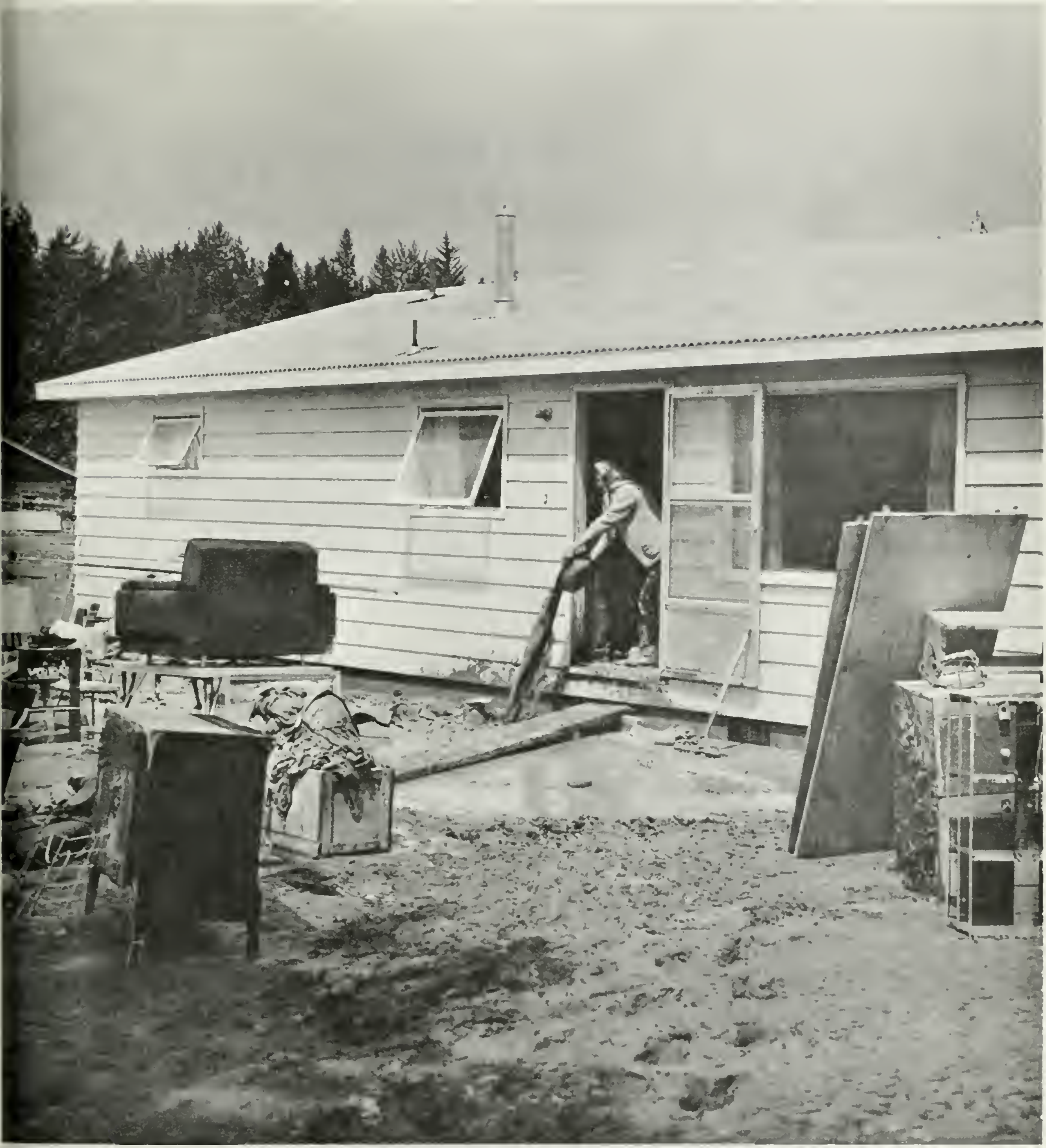


Figure 9.--CLEANUP STARTS AT HOME NEAR COLUMBIA FALLS

Water had been almost to eaves and garage was swept downriver. (Photo courtesy of Mel Ruder, Editor, Hungry Horse News.)

## FUTURE FLOODS

This section of the report discusses the Standard Project Flood and the Intermediate Regional Flood on Flathead, Stillwater and Whitefish Rivers in the vicinity of Kalispell and Columbia Falls, Montana, and some of the hazards of great floods.

The June 1964 flood was far greater in magnitude than the Standard Project Flood and the Intermediate Regional Flood. However, this is considered an extremely rare flood. The Standard Project Flood and the Intermediate Regional Flood should be used as a basis for normal development planning.

## DETERMINATION OF INTERMEDIATE REGIONAL FLOODS

The Intermediate Regional Flood is defined as a flood at any given location having an average frequency of occurrence in the order of once in 100 years, although the flood may occur in any year. Some probability estimates are based on statistical analyses of streamflow records available for the watershed under study, but limitations in such records usually require analyses of rainfall and runoff characteristics in the "general region" of the area under study. The Intermediate Regional Flood represents a major flood, although it is much less severe than the Standard Project Flood. Table 9 lists the maximum known floods that have occurred on watersheds comparable with the Flathead, Stillwater and Whitefish Rivers and within the same geographical region.

## TABLE 9

## MAXIMUM KNOWN FLOOD DISCHARGES ON STREAMS IN THE REGION OF KALISPELL, MONTANA

| Stream | Location | Drainage Area sq. mi. | Date | Peak Discharge |  |
|---|---|---|---|---|---|
|  |  |  |  | Amount cfs | Per Sq. Mi. cfs |
| St. Regis River | Near St. Regis | 303 | May 19, 1954 | 11,000 | 36.0 |
| Thompson River | Near Thompson Falls | 642 | June 9, 1964 | 6,080 | 9.5 |
| Swan River | Near Bigfork | 671 | May 24, 1948 | 8,400 | 12.5 |
| Blackfoot River | Near Bonner | 2,290 | June 10, 1964 | 19,200 | 8.4 |
| Clark Fork | At St. Regis | 10,709 | May 24, 1948 | 68,900 | 6.4 |

In order to determine the Intermediate Regional Floods for Flathead, Stillwater and Whitefish Rivers, statistical studies were made using the 42-year record of known flows of Flathead River at Columbia Falls and the 22-year record of known flows for the gaging stations, Stillwater River near Whitefish and Whitefish River near Kalispell. Longer records of Flathead River near Polson and Swan River near Bigfork were used to extend the effective records of the above stations.

The Intermediate Regional Flood investigations for Flathead River included studies of the affect of regulation of South Fork of the Flathead River (Hungry Horse Dam) upon future floods. The results of these studies indicate the Intermediate Regional Flood on the Flathead River at Columbia Falls would have a peak discharge of 79,000 cubic feet per second. The Intermediate Regional Floods at the gaging stations on Stillwater River and Whitefish River would be 6,200 and 1,680 cubic feet per second, respectively. Peak discharges of the Intermediate Regional Floods at the gaging stations on Flathead, Stillwater and Whitefish Rivers are shown in Table 10.

## TABLE 10

## INTERMEDIATE REGIONAL FLOOD

## PEAK DISCHARGE

| Stream | Location | River Mile | Drainage Area sq. mi. | Discharge cfs |
|---|---|---|---|---|
| Flathead River | Columbia Falls (USGS Gage) | 143.0 | 4,464 | 79,000 |
| Stillwater River | USGS Gage[1/] | 12.0 | 394 | 6,200 |
| Whitefish River | USGS Gage[1/] | 8.0 | 170 | 1,680 |

[1/] Gage station was discontinued in 1950.

Sufficient data are not available to definitely establish the exact discharges that would occur throughout the Flathead, Stillwater and Whitefish River Basins during Intermediate Regional Floods. Intermediate Regional Flood profiles for Flathead River were developed from several observed water surface profiles including the May 1948 and June 1964 flood profiles. Intermediate Regional Flood profiles for Stillwater River and Whitefish River were developed by routing the Intermediate Regional Floods at the respective gaging stations downstream to the Flathead River, using hydraulic studies to establish the profile elevations. Intermediate Regional Flood profiles for the Flathead, Stillwater and Whitefish Rivers are shown on Plates 12 through 15.

Intermediate Regional Floods may occur on Flathead River at Columbia Falls that are about 9 feet lower than the June 1964 flood at that location. East of Kalispell near U. S. Highway No. 2 bridge, the Intermediate Regional Flood would be about 2.5 feet lower than the June 1964 flood. Similar stage comparisons cannot be made on Stillwater River and Whitefish River within the limits of this study due to lack of data on past floods.

## DETERMINATION OF STANDARD PROJECT FLOODS

Only in rare instances has a specific stream experienced the largest flood that is likely to occur. The June 1964 flood on the Flathead River was of this rare magnitude. The Corps of Engineers in cooperation with the U. S. Weather Bureau has made broad and comprehensive studies and investigations based on the vast records of experienced storms and floods and has evolved generalized procedures for estimating the flood potential of streams. These procedures have been used in determining the Standard Project Floods. This flood is defined as the largest that can be expected from the most severe combination of meteorological and hydrological conditions that are considered reasonably characteristic of the geographical region involved, excluding extremely rare events like the June 1964 flood.

Standard Project Flood estimates have been made for Flathead River at Columbia Falls gaging station, Stillwater River near Whitefish gaging station, and Whitefish River near Kalispell gaging station. The Standard Project Floods of Flathead, Stillwater and Whitefish Rivers at these locations are 100,000 cubic feet per second, 10,000 cubic feet per second and 2,000 cubic feet per second, respectively. Peak discharges of the Standard Project Flood on Flathead, Stillwater and Whitefish Rivers are shown in Table 11.

## TABLE 11

## STANDARD PROJECT FLOOD

## PEAK DISCHARGE

| Stream | Location | River Mile | Drainage Area sq. mi. | Discharge cfs |
|---|---|---|---|---|
| Flathead River | Columbia Falls (USGS Gage) | 143.0 | 4,464 | 100,000 |
| Stillwater River | USGS Gage[1/] | 12.0 | 394 | 10,000 |
| Whitefish River | USGS Gage[1/] | 8.0 | 170 | 2,000 |

[1/] Gage station was discontinued in 1950.

Storm rainfall used to develop the Standard Project Flood for Flathead River at Columbia Falls amounts to 0.22 inches in 6 hours, 0.50 inches in 12 hours, 1.73 inches in 24 hours, 3.95 inches in 48 hours, and a total of 4.60 inches in 72 hours.

Standard Project Floods for Stillwater River and Whitefish River were estimated from Standard Project Flood at Columbia Falls based on the streamflow and drainage area relationships of the respective gaging stations.

Standard Project Flood profiles for the three rivers within the limits of this study were developed following the same procedures used to develop Intermediate Regional Flood profiles. Standard Project Flood profiles are shown on Plates 12 through 15.

## Frequency

No frequency is assigned to the Standard Project Flood. The occurrence of such a flood would be a rare event; however, it could occur in any year.

## Possible Larger Floods

Floods larger than the Standard Project Flood are possible. A unique example of such an occurrence is the flood of June 1964 on the Flathead River when peak discharges substantially greater than those of a Standard Project Flood were actually experienced. Because of the combination of factors that are necessary to produce a Standard Project Flood, the probability of such a flood is remote. The consideration of floods of this magnitude is of greater importance in some problems than in others but should not be overlooked in the study of any problem.

# HAZARDS OF GREAT FLOODS

The amount and extent of damage caused by any flood depends in general upon how much area is flooded, the height of flooding, the velocity of flow, the rate of rise, and the duration of flooding.

## Areas Flooded and Heights of Flooding

The areas along Flathead, Stillwater and Whitefish Rivers flooded by the Standard Project and Intermediate Regional Floods are shown on Plates 7 through 11. Depths of flow can be estimated from crest profiles shown on Plates 12 through 15.

The profiles for the streams were computed by using stream characteristics for selected reaches as determined from observed flood profiles, topographic maps and valley cross sections which were surveyed in October 1968. The Stillwater and Whitefish River profiles were computed by using fragmentary stream flow records at the gaging stations described on page 27. The elevations shown on Plates 12 through 15 and the overflow areas shown on Plates 7 through 11 have been determined with an accuracy consistent with the purposes of this study and the accuracy of the basic data.

The profiles of the Standard Project and the Intermediate Regional Floods depend in part upon the degree of destruction or clogging of various bridges during the flood. Because we cannot forecast these events, we assume all bridge structures would stand and no clogging would occur.

The June 1964 flood profile for the Flathead River is 1.5 to 6.9 feet higher than the Standard Project Flood. The maximum difference occurs at Red bridge near Columbia Falls and is the result of narrowing of the valley. The Standard Project Flood profile for Stillwater River is 0.5 to 3.5 feet higher than the Intermediate Regional Flood. The maximum difference occurs at the 7th Avenue E. N. bridge resulting from narrowing of the valley. The Standard Project Flood profile for Whitefish River is 0.5 to 1 foot higher than the Intermediate Regional Flood. The maximum difference occurs near the mouth due to backwater effects from Stillwater River.

Figures 10 and 11 on page 49 show the heights that would be reached by the Standard Project and the Intermediate Regional Floods on facilities existing within the flood plain near Evergreen.

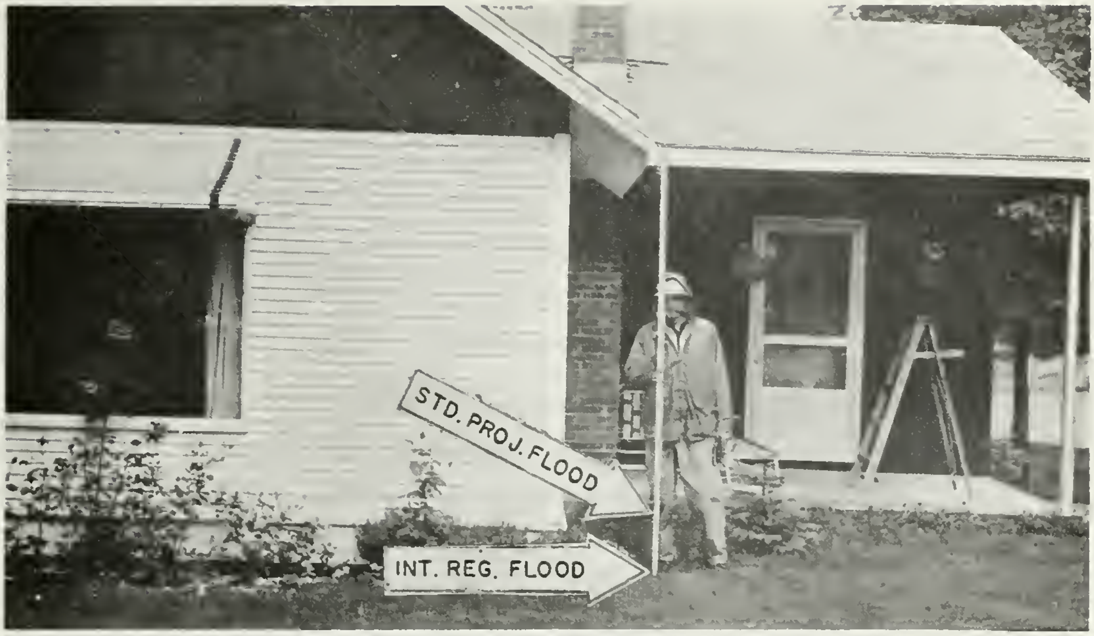


Figure 10.--FLOOD HEIGHTS AT RESIDENCE IN EVERGREEN

This house is on the left bank of the Stillwater River just upstream of the U. S. Highway No. 2 twin bridges in the community of Evergreen. The levels reached by the Intermediate Regional Flood and Standard Project Flood are shown.

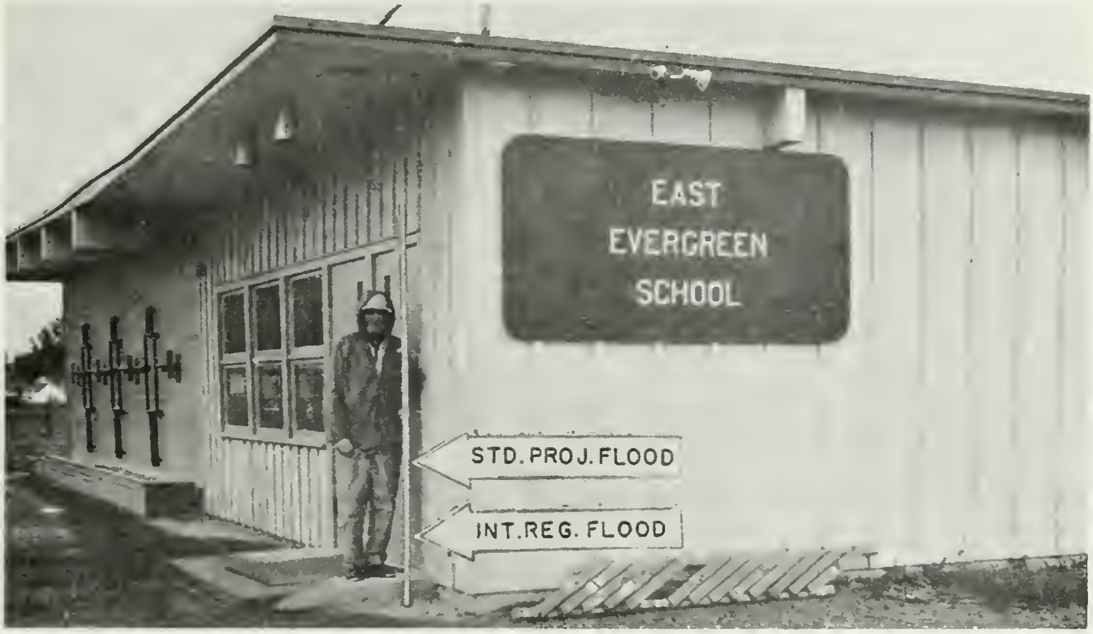


Figure 11.--FLOOD HEIGHTS AT EAST EVERGREEN SCHOOL

The East Evergreen School is on the right bank of the Flathead River at the end of Pheasant Drive in the community of Evergreen. The levels reached by the Intermediate Regional Flood and Standard Project Flood are shown.

## Velocities, Rates of Rise, and Duration

Water velocities during floods depend largely upon the size and shape of the cross section, the condition of the stream, and the bed slope; all of which vary on different streams and at different locations on the same streams.

Table 12 lists the maximum velocities that would occur in the main channel and overbank areas of Flathead, Stillwater and Whitefish Rivers during the Intermediate Regional Flood.

### TABLE 12

### INTERMEDIATE REGIONAL FLOOD

### MAXIMUM VELOCITIES

| Stream | Location | Maximum Velocities<br>Channel ft. per sec. | Overbank ft. per sec. |
|---|---|---|---|
| Flathead River | Columbia Falls (USGS Gage) | 11.7 | 1.9 |
| | U. S. Highway No. 2 Bridge (northeast of Kalispell) | 6.3 | 1.8 |
| Stillwater River | Near Mouth | 3.0 | 1.7 |
| Whitefish River | Near Mouth | 2.5 | 0.2 |

Table 13 lists the maximum velocities that would occur in the main channel and overbank areas of Flathead, Stillwater and Whitefish Rivers during the Standard Project Floods.

## TABLE 13

## STANDARD PROJECT FLOOD

## MAXIMUM VELOCITIES

| Stream | Location | Maximum Velocities Channel ft. per sec. | Maximum Velocities Overbank ft. per sec. |
|---|---|---|---|
| Flathead River | Columbia Falls (USGS Gage) | 13.3 | 2.5 |
| | U. S. Highway No. 2 Bridge (northeast of Kalispell) | 7.8 | 2.0 |
| Stillwater River | Near Mouth | 3.3 | 2.0 |
| Whitefish River | Near Mouth | 2.7 | 0.2 |

Table 14 lists the total rise above low water to the crest of the Intermediate Regional Flood, maximum rate of rise, and the duration of flooding of the Intermediate Regional Flood for Flathead, Stillwater and Whitefish Rivers.

## TABLE 14

## INTERMEDIATE REGIONAL FLOOD

## RATES OF RISE AND DURATION

| Stream | Location | Height of Rise feet | Maximum Rate of Rise ft. per day | Duration of Flooding days |
|---|---|---|---|---|
| Flathead River | Columbia Falls | 7.0 | 5.0 | 2 |
| | U. S. Highway No. 2 Bridge | 3.5 | 2.5 | 2-5 |
| Stillwater River | Near Mouth | 8.0 | 1.0 | 8 |
| Whitefish River | Near Mouth | 6.0 | 3.0 | 10 |

Table 15 lists the total rise above low water to the crest of the Standard Project Flood, the maximum rate of rise, and the duration of flooding of the Standard Project Flood for Flathead, Stillwater and Whitefish Rivers at the designated locations.

## TABLE 15

## STANDARD PROJECT FLOOD

## RATES OF RISE AND DURATION

| Stream | Location | Height of Rise feet | Maximum Rate of Rise ft. per day | Duration of Flooding days |
|---|---|---|---|---|
| Flathead River | Columbia Falls | 9 | 7 | 3 |
| | U. S. Highway No. 2 Bridge | 4 | 3 | 3-7 |
| Stillwater River | Near Mouth | 10 | 2 | 12 |
| Whitefish River | Near Mouth | 8 | 4 | 15 |

## GLOSSARY OF TERMS

Flood: An overflow of lands not normally covered by water and that are used or usable by man. Floods have two essential characteristics: The inundation of land is temporary; and the land is adjacent to and inundated by overflow from a river or stream or an ocean, lake, or other body of standing water.

Normally a "flood" is considered as any temporary rise in stream flow or stage, but not the ponding of surface water, that results in significant adverse effects in the vicinity. Adverse effects may include damages from overflow of land areas, temporary backwater effects in sewers and local drainage channels, creation of unsanitary conditions or other unfavorable situation by deposition of materials in stream channels during flood recessions, rise of ground water coincident with increased stream flow, and other problems.

Flood Crest: The maximum stage or elevation reached by the waters of a flood at a given location.

Flood Peak: The maximum instantaneous discharge of a flood at a given location. It usually occurs at or near the time of the flood crest.

Flood Plain: The relatively flat area or low lands adjoining the channel of a river, stream or watercourse or ocean, lake, or other body of standing water, which has been or may be covered by flood water.

Flood Profile: A graph showing the relationship of water surface elevation to location, the latter generally expressed as distance above mouth for a stream of water flowing in an open channel. It is generally drawn to show surface elevation for the crest of a specific flood, but may be prepared for conditions at a given time or stage.

Flood Stage: The stage or elevation at which overflow of the natural banks of a stream or body of water begins in the reach or area in which the elevation is measured.

Head Loss: The effect of obstructions, such as narrow bridge openings or buildings that limit the area through which water must flow, raising the surface of the water upstream from the obstruction.

Intermediate Regional Flood: A flood having an average frequency of occurrence in the order of once in 100 years although the flood may occur in any year. It is based on statistical analyses of streamflow records available for the watershed and analyses of rainfall and runoff characteristics in the "general region of the watershed."

Left Bank: The bank on the left side of a river, stream, or watercourse, looking downstream.

Low Steel (or Underclearance): See "Underclearance."

Right Bank: The bank on the right side of a river, stream, or watercourse, looking downstream.

Standard Project Flood: The flood that may be expected from the most severe combination of meteorological and hydrological conditions that is considered reasonably characteristic of the geographical area in which the drainage basin is located, excluding extremely rare combinations. Peak discharges for these floods are generally about 40 percent to 60 percent of the Probable Maximum Floods for the same basins. Such floods, as used by the Corps of Engineers, are intended as practicable expressions of the degree of protection that should be sought in the design of flood control works, the failure of which might be disastrous.

Underclearance: The lowest point of a bridge or other structure over or across a river, stream, or watercourse that limits the opening through which water flows. This is referred to as "low steel" in some regions.

## AUTHORITY, ACKNOWLEDGMENT, AND INTERPRETATION OF DATA

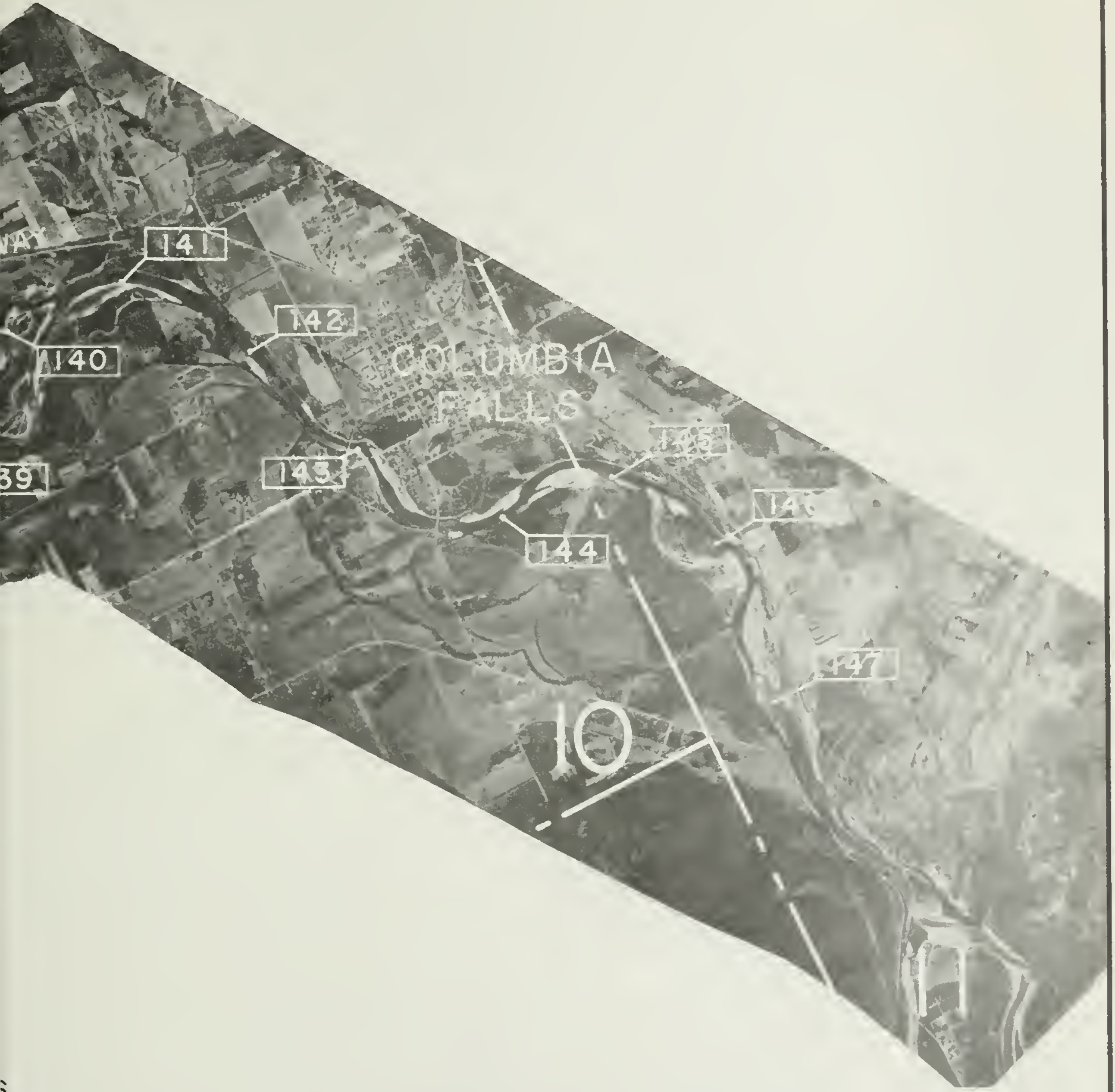
This report has been prepared in accordance with the authority granted by Section 206 of the Flood Control Act of 1960 (PL 86-645), as amended.

* * *

Assistance and cooperation of the U. S. Weather Bureau, U. S. Geological Survey , Montana State Water Resources Board, the cities of Kalispell and Columbia Falls, and private citizens in supplying useful data are appreciated.

* * *

This report presents the local flood situation for Kalispell and Columbia Falls. The Seattle District of the Corps of Engineers will, upon request, provide technical assistance to Federal, State and local agencies in the interpretation and use of the information contained herein and will provide other available flood data related thereto.



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# INDEX MAP - FLOODED AREAS

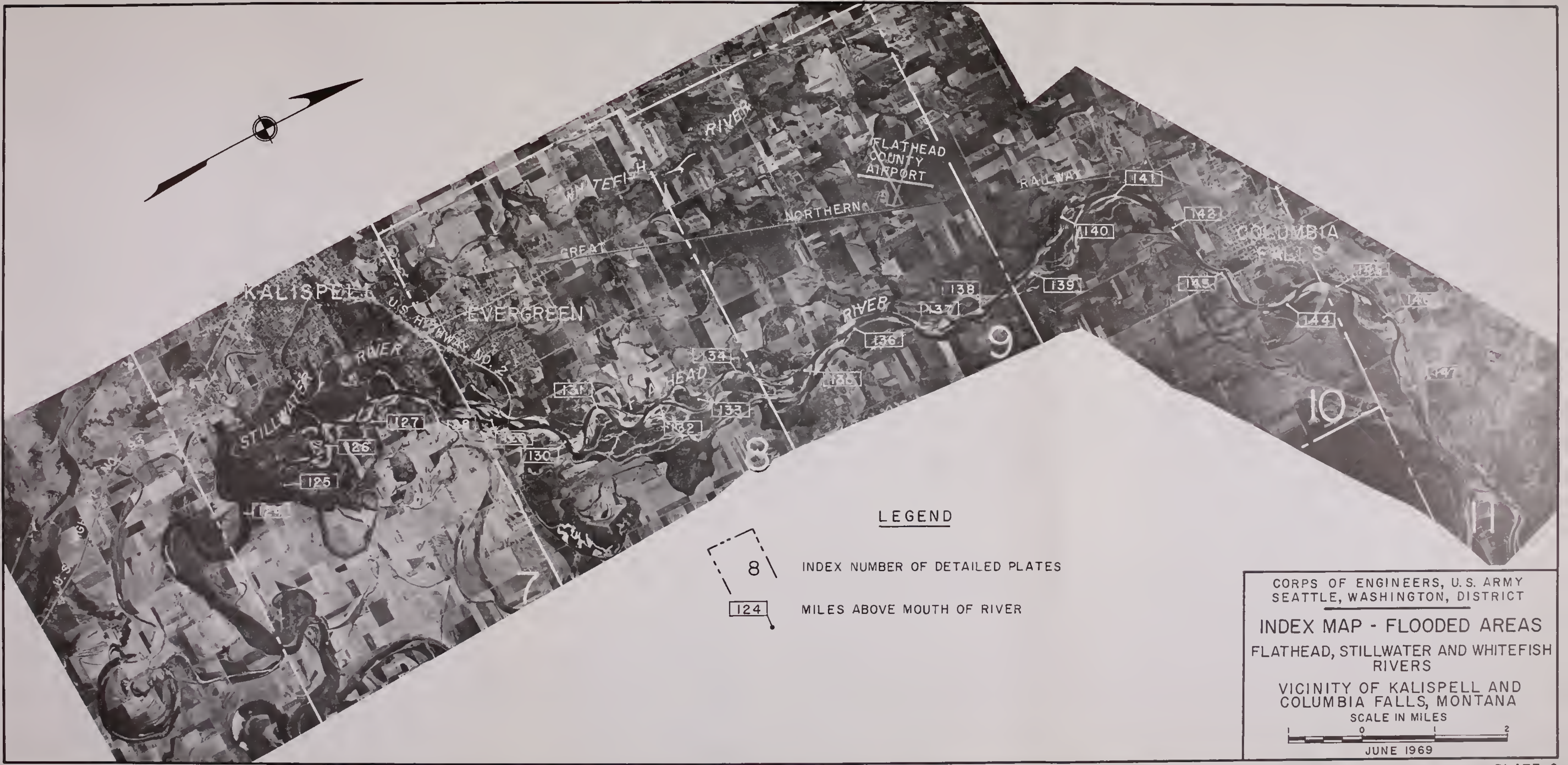
## FLATHEAD, STILLWATER AND WHITEFISH RIVERS

## VICINITY OF KALISPELL AND COLUMBIA FALLS, MONTANA

SCALE IN MILES

1 0 1 2

JUNE 1969



LEGEND

8 INDEX NUMBER OF DETAILED PLATES

124 MILES ABOVE MOUTH OF RIVER

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INDEX MAP - FLOODED AREAS

FLATHEAD, STILLWATER AND WHITEFISH RIVERS

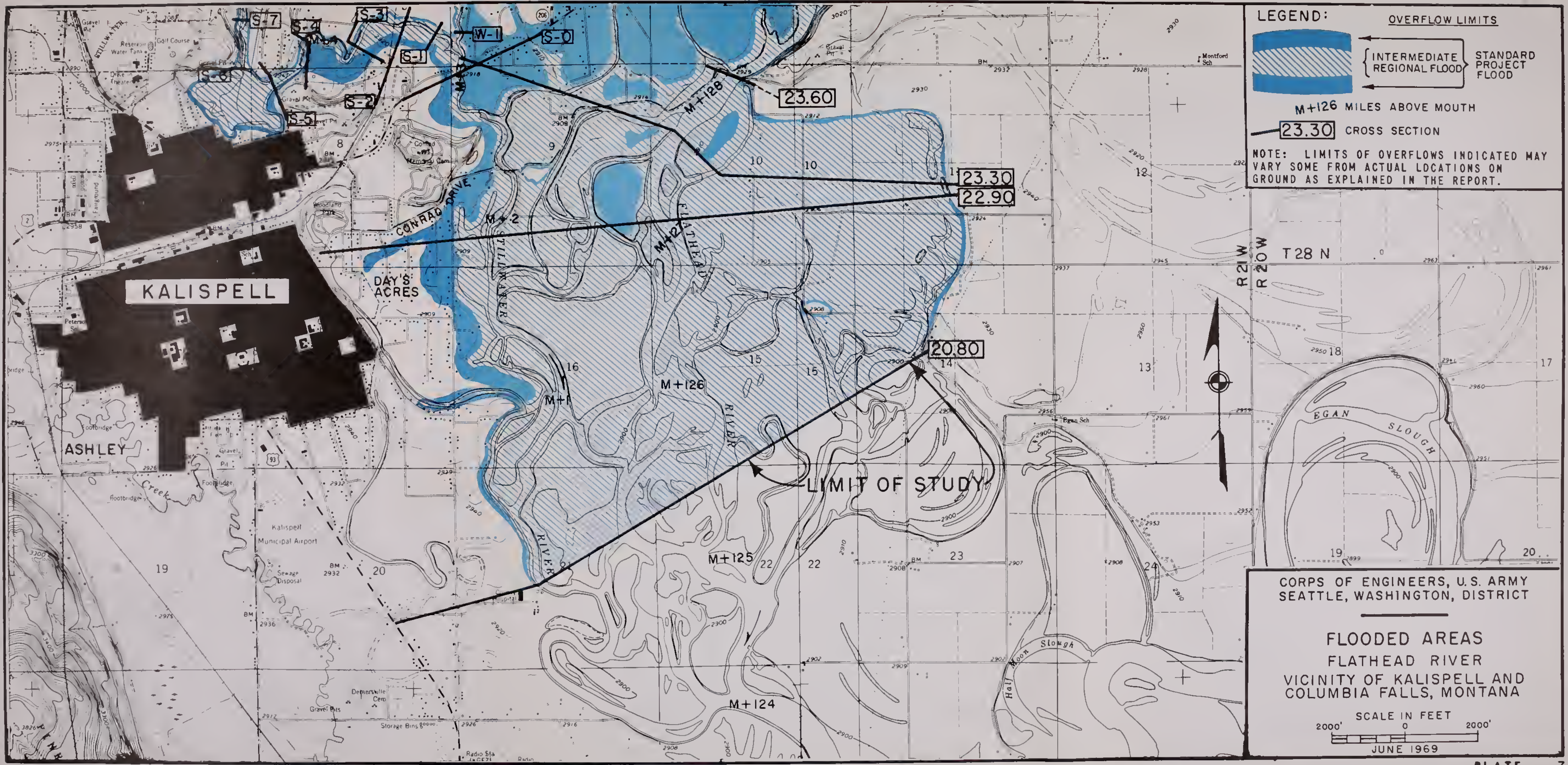
VICINITY OF KALISPELL AND
COLUMBIA FALLS, MONTANA

SCALE IN MILES

1 0 1 2

JUNE 1969

PLATE 6



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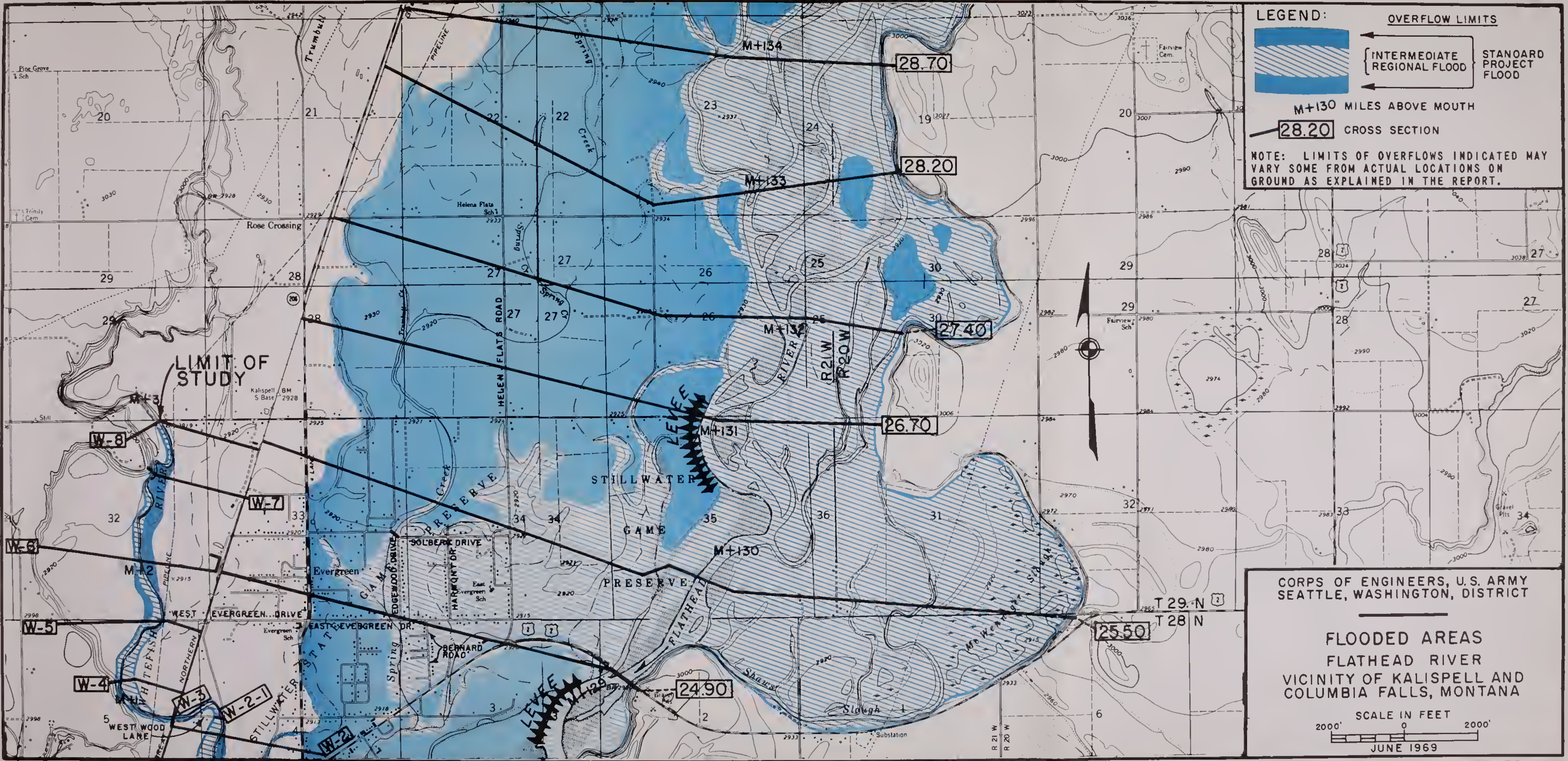
## FLOODED AREAS
FLATHEAD RIVER
VICINITY OF KALISPELL AND COLUMBIA FALLS, MONTANA

SCALE IN FEET
2000' 0 2000'
JUNE 1969

PLATE 7



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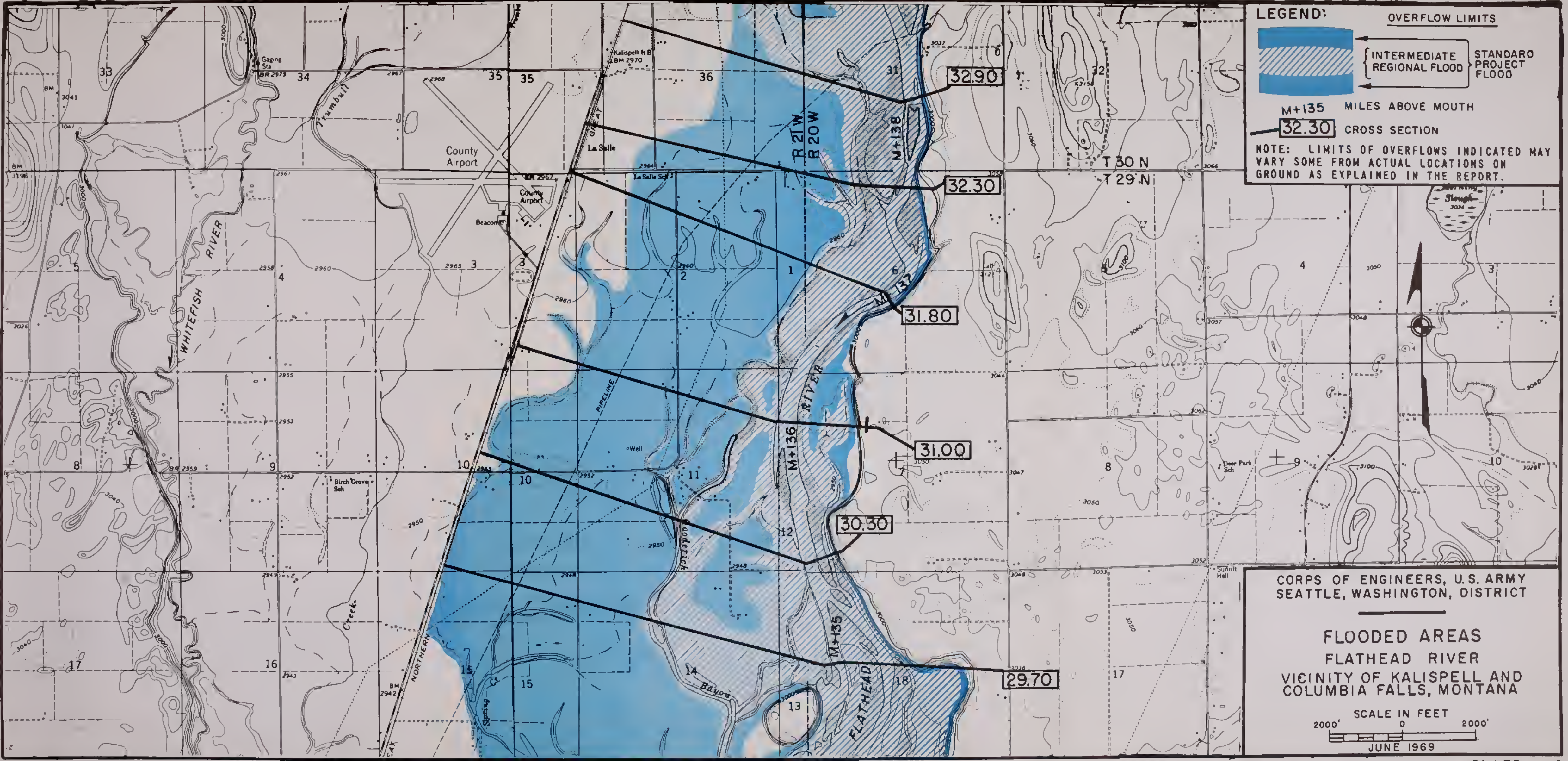
FLOODED AREAS
FLATHEAD RIVER
VICINITY OF KALISPELL AND
COLUMBIA FALLS, MONTANA

SCALE IN FEET
2000' 0 2000'
JUNE 1969

PLATE 8



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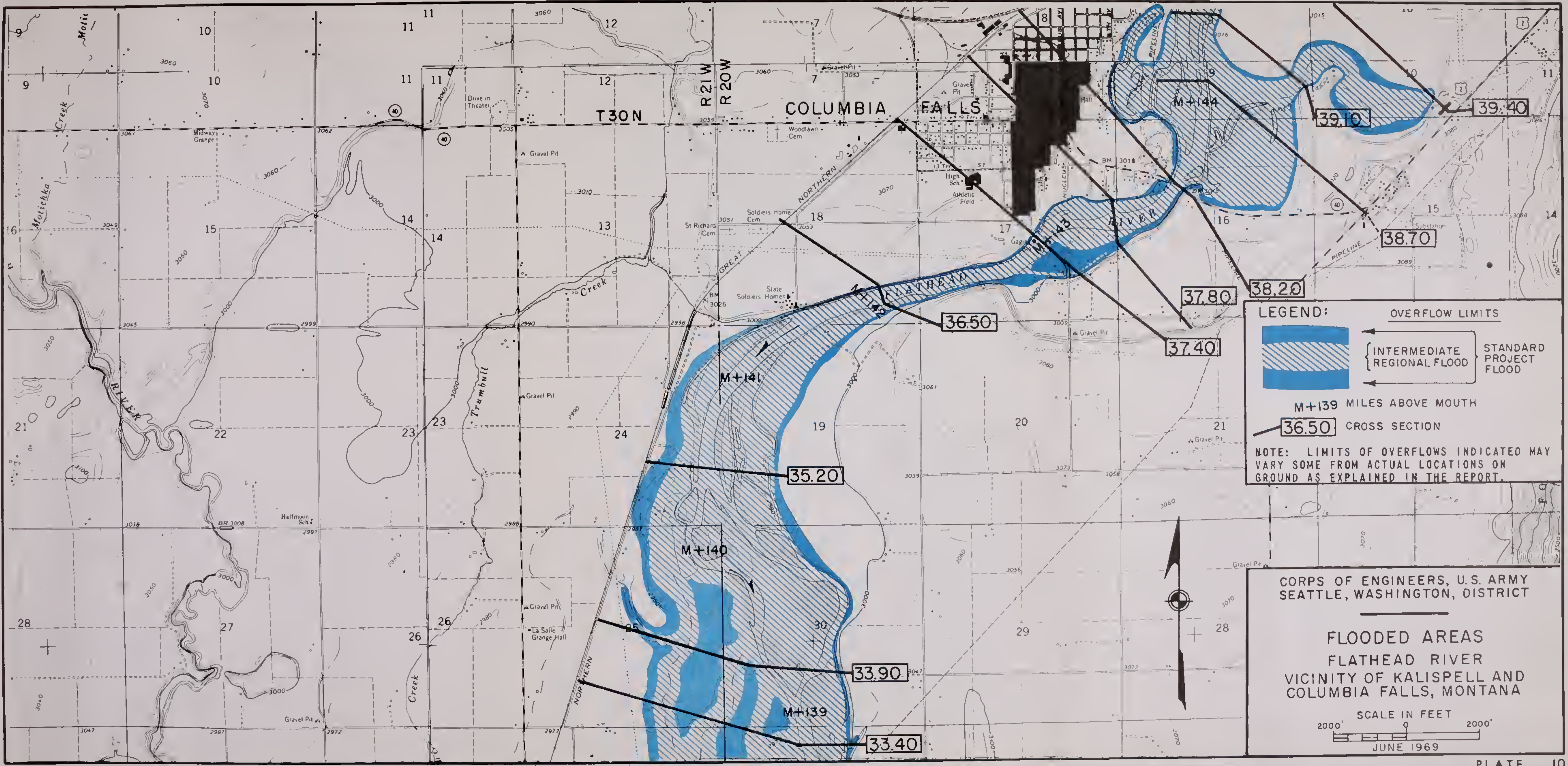
## FLOODED AREAS
## FLATHEAD RIVER
## VICINITY OF KALISPELL AND COLUMBIA FALLS, MONTANA

SCALE IN FEET
2000' 0 2000'

JUNE 1969

PLATE 9



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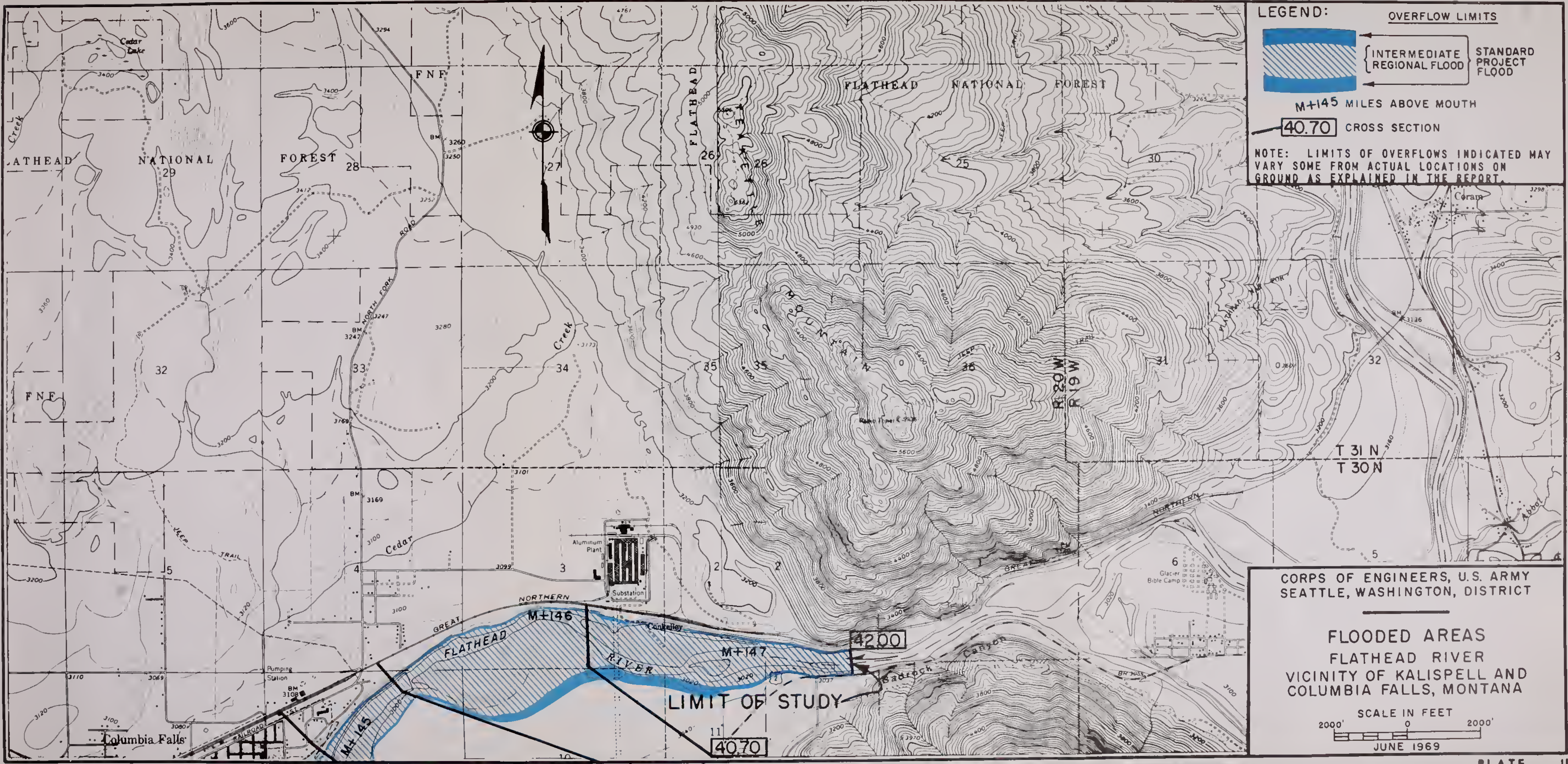
FLOODED AREAS
FLATHEAD RIVER
VICINITY OF KALISPELL AND
COLUMBIA FALLS, MONTANA

JUNE 1969

PLATE 10



LEGEND:

OVERFLOW LIMITS

{INTERMEDIATE REGIONAL FLOOD} STANDARD PROJECT FLOOD

M+145 MILES ABOVE MOUTH

40.70 CROSS SECTION

NOTE: LIMITS OF OVERFLOWS INDICATED MAY VARY SOME FROM ACTUAL LOCATIONS ON GROUND AS EXPLAINED IN THE REPORT.

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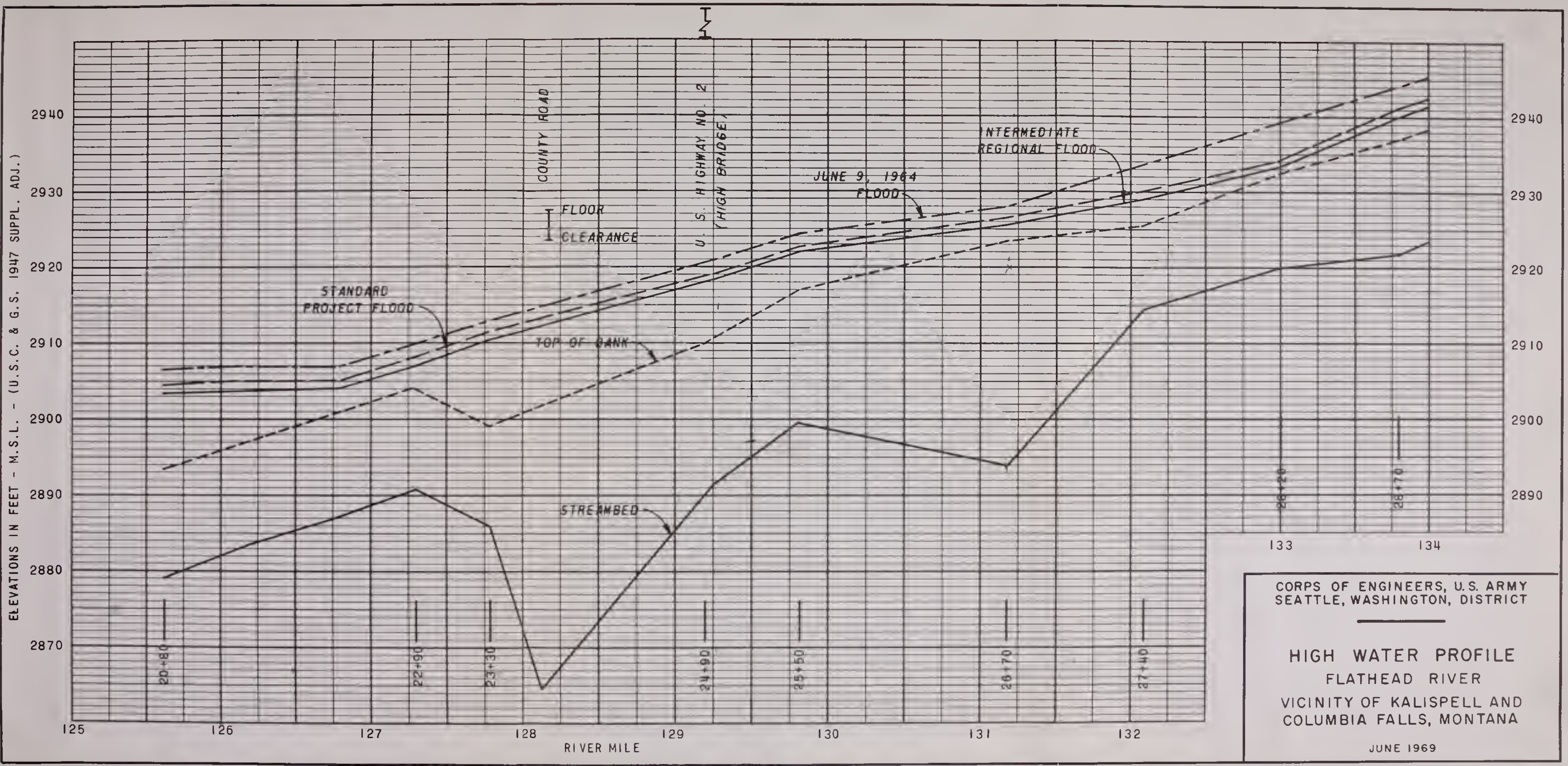
FLOODED AREAS
FLATHEAD RIVER
VICINITY OF KALISPELL AND
COLUMBIA FALLS, MONTANA

SCALE IN FEET
2000' 0 2000'

JUNE 1969

PLATE 11



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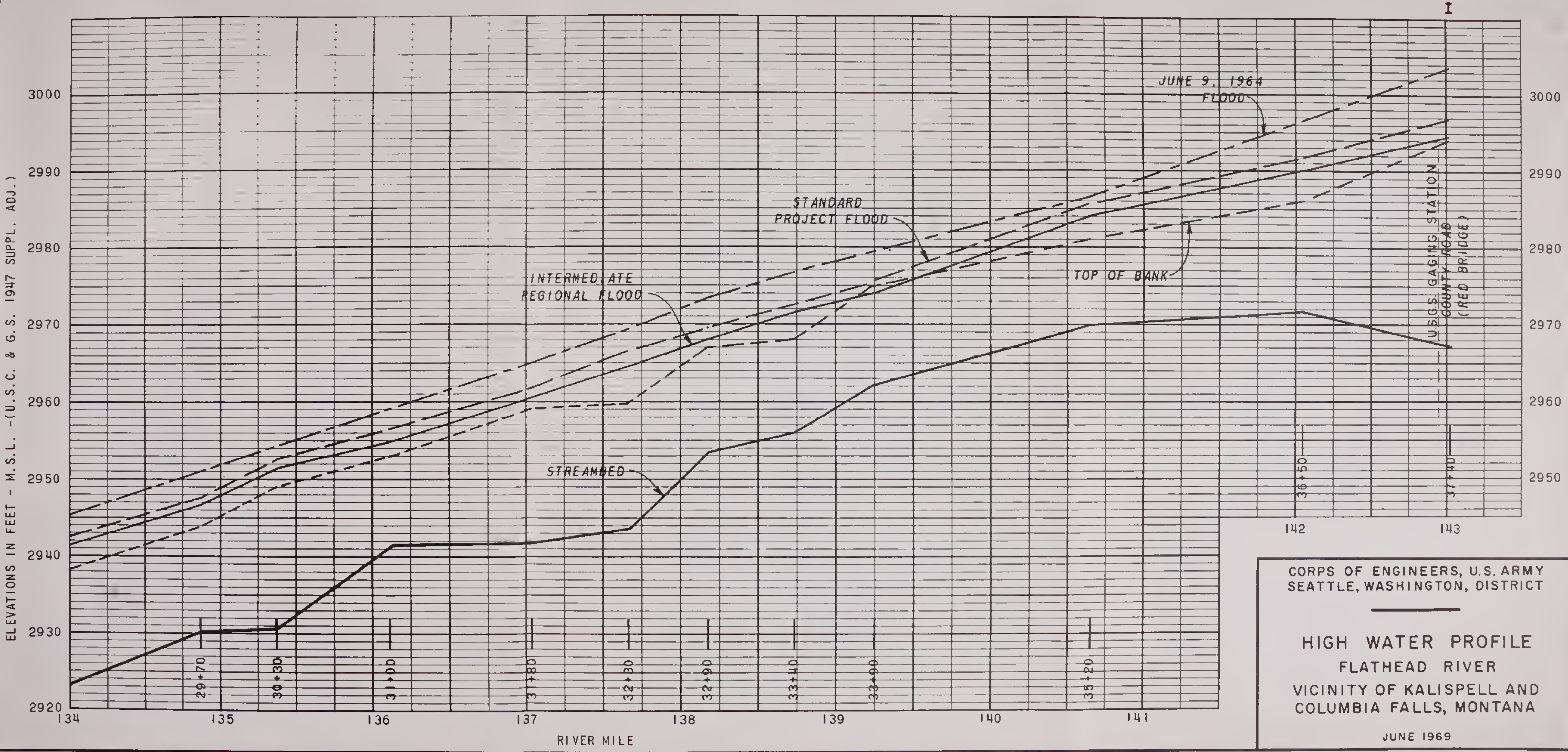
## HIGH WATER PROFILE
FLATHEAD RIVER
VICINITY OF KALISPELL AND
COLUMBIA FALLS, MONTANA

JUNE 1969

PLATE 12



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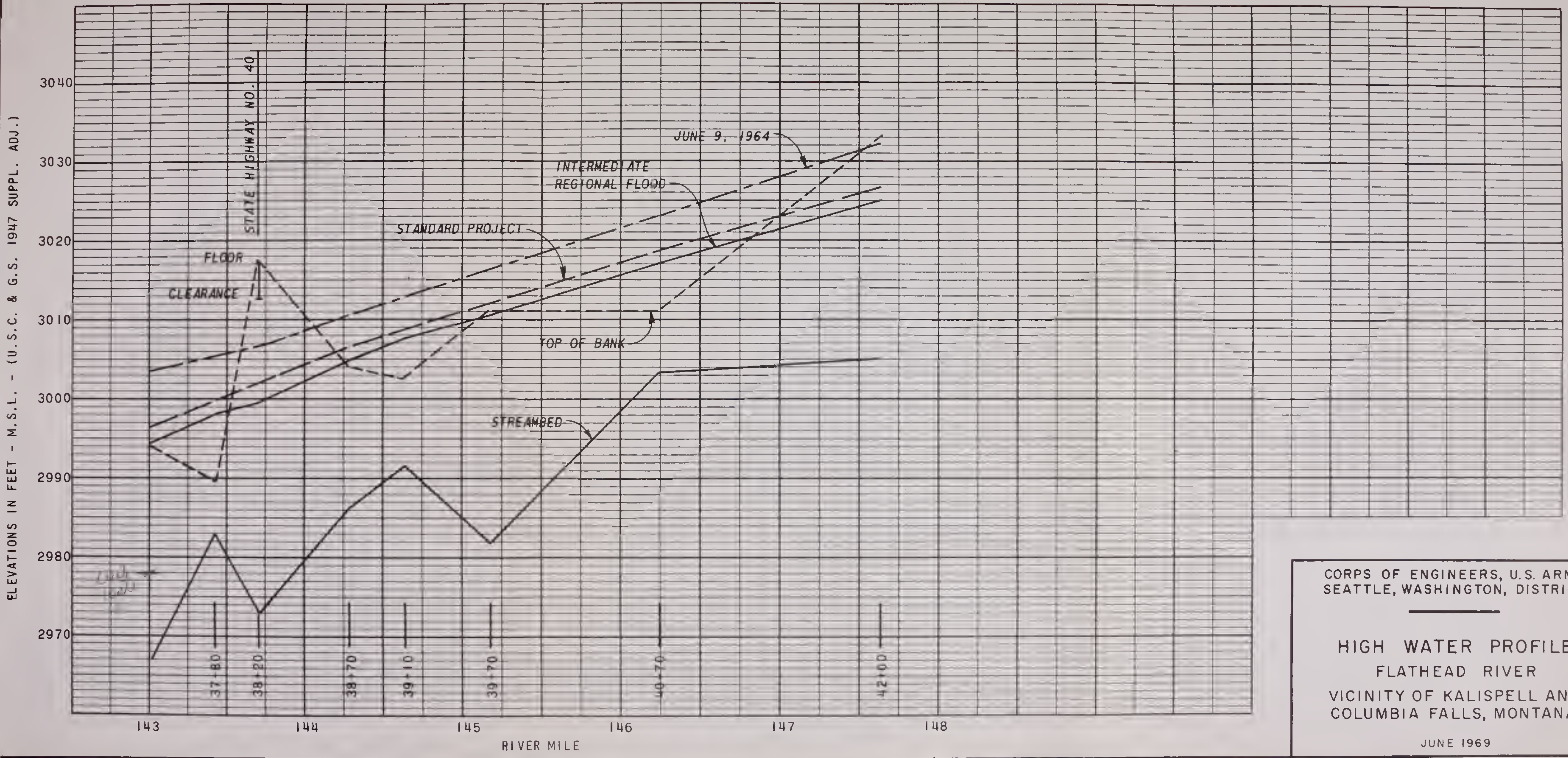
## HIGH WATER PROFILE
## FLATHEAD RIVER
## VICINITY OF KALISPELL AND COLUMBIA FALLS, MONTANA

JUNE 1969



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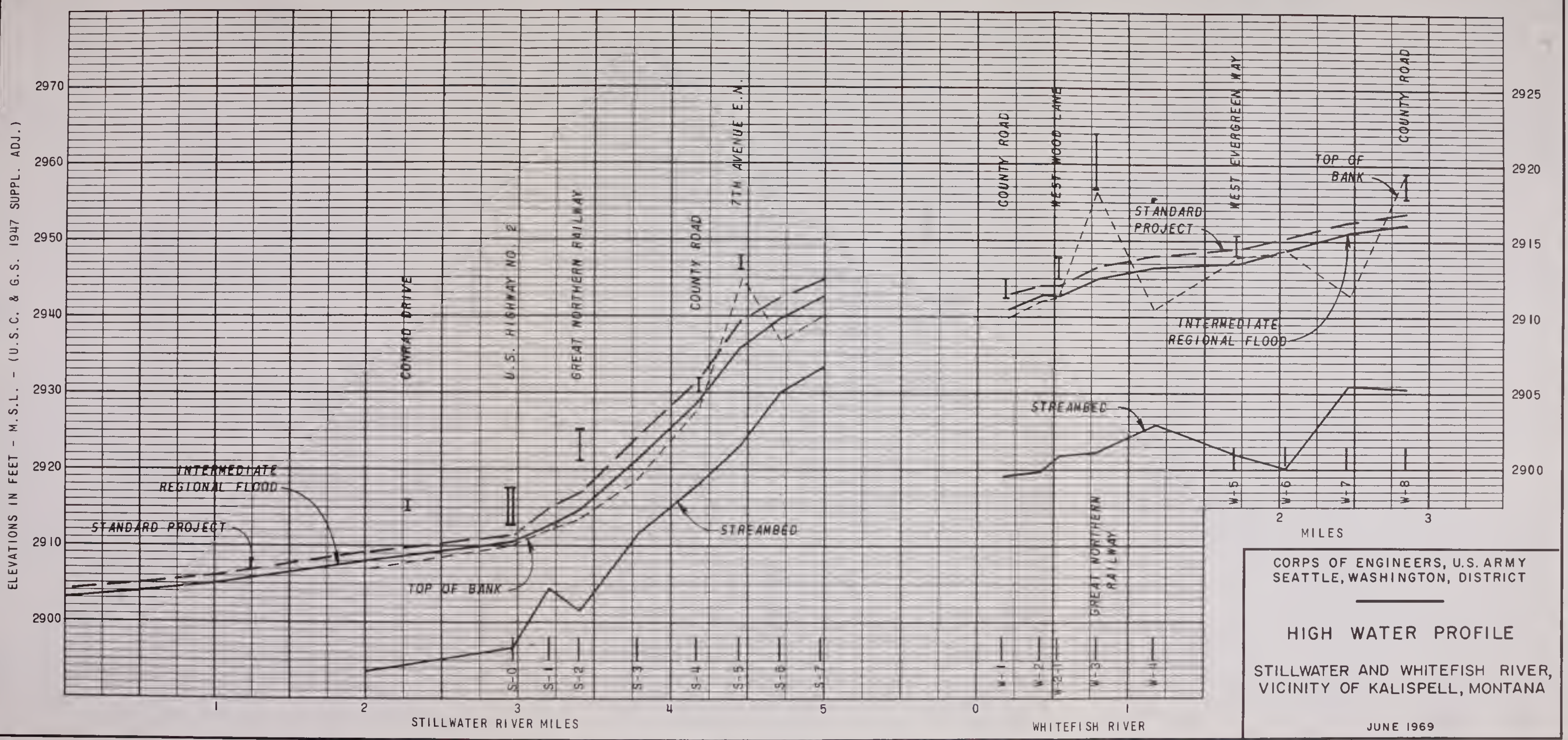
## HIGH WATER PROFILE
FLATHEAD RIVER
VICINITY OF KALISPELL AND
COLUMBIA FALLS, MONTANA

JUNE 1969

PLATE 14



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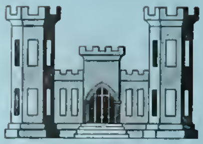
## HIGH WATER PROFILE

STILLWATER AND WHITEFISH RIVER,
VICINITY OF KALISPELL, MONTANA

JUNE 1969

PLATE 15



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